AVIATION NUMBER

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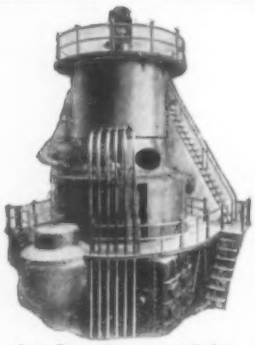
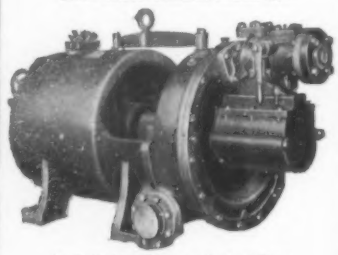


Curtis Turbine Generator, vertical type



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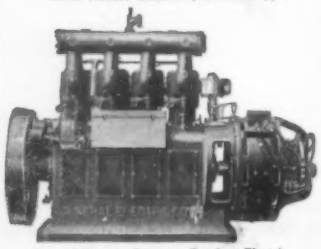
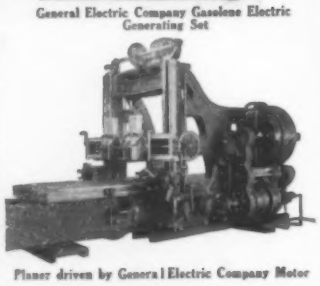
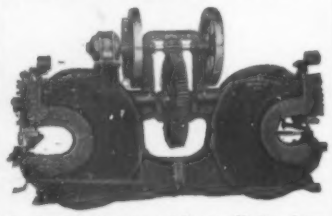


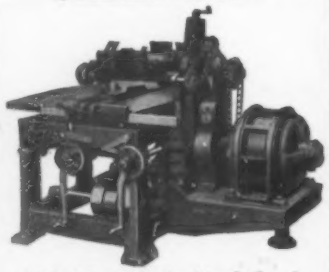
General Electric Company Gasolene Electric Generating Set



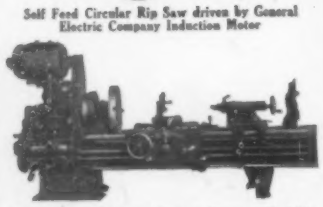
Planer driven by General Electric Company Motor



Double Ended Punching and Shearing Machine driven by General Electric Company Motor



Self Feed Circular Rip Saw driven by General Electric Company Induction Motor



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SIXTY-SEVENTH YEAR

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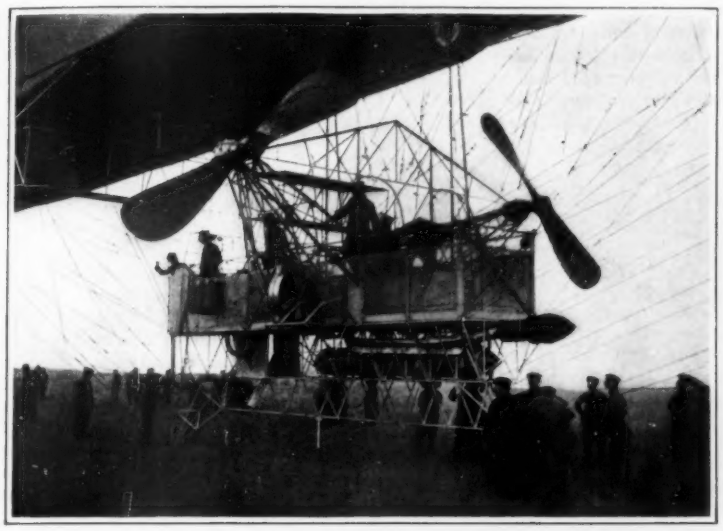
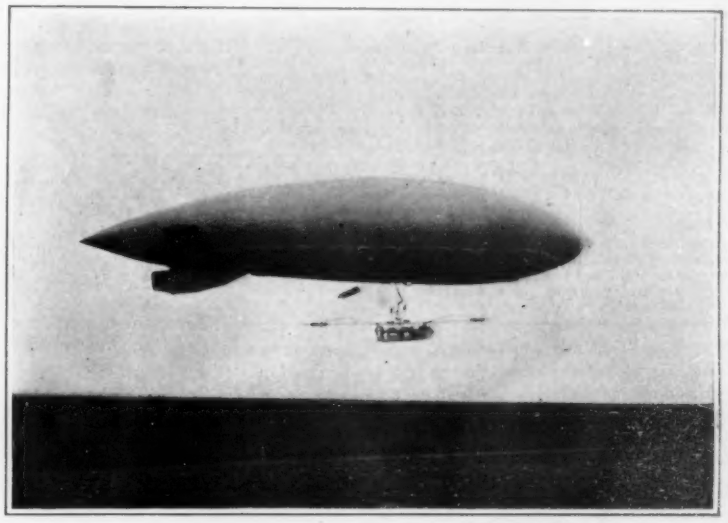
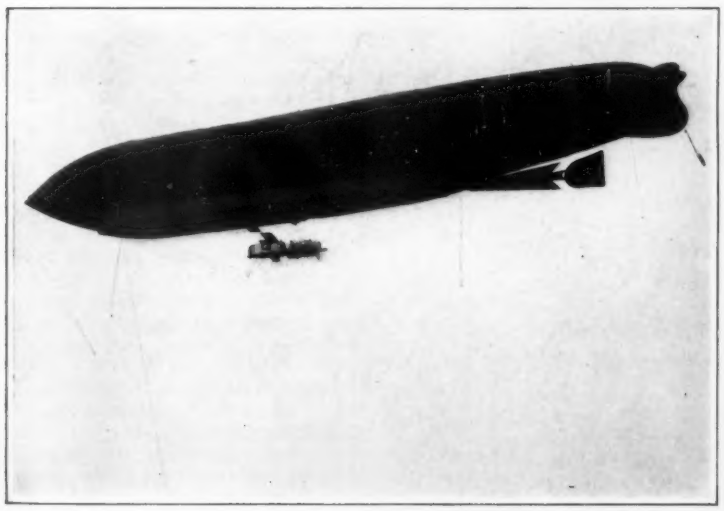


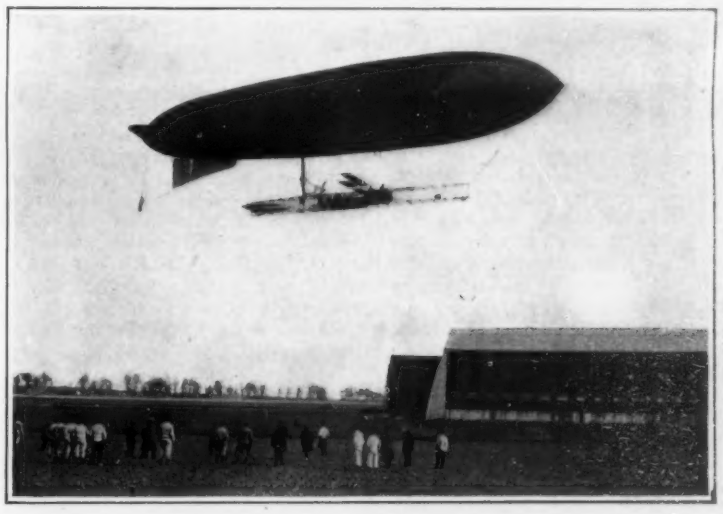
Car of the "Capitaine Marchal."



The new Austrian military airship, which is a modified Parseval.

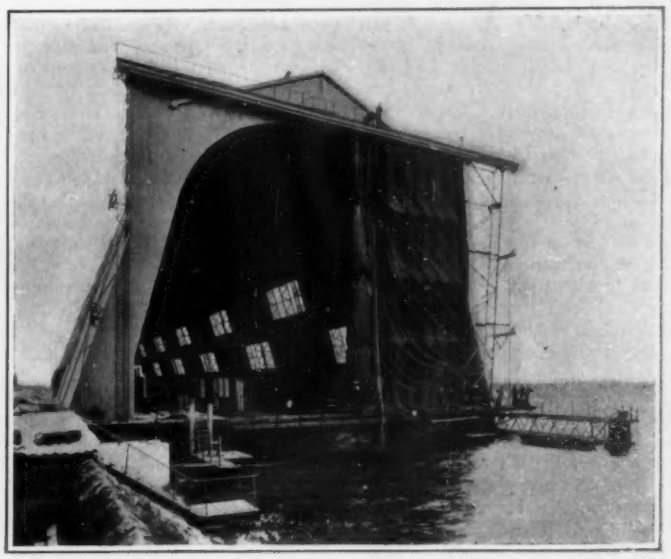


The French airship "Le Temps."



The French airship "Capitaine Marchal."

Parseval airship casting its shadow on Chemnitz, Germany.



English airship shed to house the first naval dirigible.

DIRIGIBLES OF TO-DAY.—[See page 466.]

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately and in simple terms, the world's progress in scientific knowledge and industrial achievement. It seeks to present this information in a form so readable and readily understood, as to set forth and emphasize the inherent charm and fascination of science.

Aims and Accomplishments in Aeronautics

ALTHOUGH the greater part of the present issue of the SCIENTIFIC AMERICAN is devoted to aeronautics, so rapidly has the art developed that it is possible to deal in this number only with some of its more important phases.

The world at large, and particularly the people of the United States, have heard too much about the disasters that have befallen the airship, and too little about its successes. The story of the operation of the dirigible, particularly in Germany, as told in the article on this type of air craft, will come as a great surprise to those of our readers to whom the term "dirigible" may have come to be synonymous with costly construction and dire disaster. The analysis of these very mishaps proves that they were due, not to any inherent fallacies in theory or faults of construction, but rather to certain fortuitous conditions of wind and weather or the carelessness of the crew.

The charm of a well-written biography will always be enhanced by the introduction of the personal note. In the case of a man of the public reputation of the late Octave Chanute, it is not sufficient merely to recite the events of his life; one wishes to be brought in contact with the man himself. This personal touch in the present biography of Chanute, which was written by one who for some years was a close personal friend, will render the notice particularly appropriate to the present issue.

The art of flying has not progressed so far but that there is still a wide field of fascinating investigation before us. In the article dealing with the always-tragic subject of aeroplane accidents, the writer draws attention to a most important element in the question of stability, namely, that of giving to the aeroplane sufficient flexibility to enable it to yield and adjust itself to the unevenly distributed shocks of a disturbed atmosphere. The French aviators are giving much attention to this most important question; and it should commend itself to the serious thought of American aviators. Not only increased stability, but higher speed, will attend the solution of the problem.

There are few problems of the aeroplane or dirigible that invite closer investigation or promise greater returns in efficiency, than that of the propeller. The field of aerial propulsion is fortunate in having at its disposal the valuable data obtained in the investigation of marine propellers, and the study of the aeroplane propeller contained in this number, written by a naval constructor, will prove to be of much practical assistance to builders of air craft.

It was inevitable that the matter of automatic stability should, from the very first, have stood out as one of the most, if not the most vital connected with the art of flying. Automatic stability has been prolific of many inventions. Several of these have been selected for illustration in an article on this subject, in which their method of operation, efficiency, etc., are clearly and simply discussed. The conclusion of the writer is that we shall ultimately come to a type of machine which possesses an inherent stability, independent of movable wing-tips and similar devices—a conclusion with which we heartily agree.

It is a common fallacy that the cost of one battleship could be put into a fleet of air craft whose military value would be vastly greater. As a matter of fact, as shown in the article on this subject, battleships will fight battleships and air craft will be pitted against air craft. The 70-mile aerial scout may take the place of the 25-knot scout of the sea; but beyond that the substitution will not go.

By no means of the least interest to our aeronautical readers will be the article which reviews the very promising field of the so-called valveless internal-combustion motor. Of all the requirements of the aeroplane motor, that of reliability stands first; and there are indications that when the valveless type shall be brought to its final perfected form, it will carry the art a long step forward toward that ideal motor the advent of which the aviator is still eagerly awaiting.

A Centenary in Photography

THE centenary of the birth of John William Draper, which falls within the current month, furnishes a fitting occasion to cast a retrospect over the development of the art and science of photography. For Draper was one of the earliest workers in the field, and in this country probably the first.

The history of any important invention is usually found to ascend for its origin to a very remote period. Perhaps the first recorded observation of a photo-chemical reaction is that of the "development" by sunlight of the ancient purple, as described by the Grecian princess, Eudoxia Makrembossa, A. D. 990. The darkening of silver chloride by light was discovered as early as 1556 by Fabricius, and was applied for a crude kind of copying process in 1727 by the German philologist J. H. Schulze. The first attempts at photographic portraiture were made in France, by J. A. C. Charles, who prepared simple shadow-photographs. Similar experiments were performed in 1802 by Thomas Wedgewood, who also tried, though without success, to obtain an impression, upon silver nitrate paper, of the image formed in a "camera." But the chief credit in putting photography on a practical basis must undoubtedly be given to Niepce and Daguerre, who joined forces in 1829 in perfecting the process of "heliography" invented in 1816 by Niepce. The final result was the famous daguerreotype process, given to the world in 1839. Through Samuel F. B. Morse, information of the new process reached Prof. J. W. Draper of New York University, who in the year following obtained the first sunlight portrait of a human face.

Since then developments have taken place rapidly and in all directions, so that to-day, not only are a great variety of photographic processes worked out to great perfection, but the applications of photography in science and art have reached an importance which could hardly have been foreseen at the time of Daguerre and Prof. Draper. The process of ordinary photography has been so much simplified that the unskilled amateur has no difficulty in securing pictures of any subject, whether at rest or in motion. The perfection of the instantaneous shutter has furnished Edison with the means for evolving from a crude toy, known as the zoetrope, the modern kinetoscope, which not only affords entertainment and disseminates information among the people, but has served its function also in serious scientific pursuits.

While the photographic plate is less sensitive than the eye as regards its response to a stimulus of short duration, it is nevertheless capable of revealing to us objects whose light is too faint to affect our eye, for upon prolonged exposure the effect upon the photographic plate is cumulative. In this way stars have been photographed which the eye cannot directly observe. Spectro-photography has revealed to us the chemical constitution of the sun and other orbs, and stereoscopic photography enables us to see astronomical objects as they would appear to some gigantic being, whose eyes were a million miles apart.

If telescope and microscope have overcome some of the limitations of our senses as regards distances great and small, the X-rays have furnished us with the means of obtaining a view of objects hidden behind an opaque covering, and again the photographic plate comes to our aid to record the structures disclosed. And the latest development, the transmission of photographs by telegraphic means, overcomes at once distance and obstacles obstructing normal vision. We are placed, as it were, in sentient communication with eyes reaching out hundreds of miles from our natural body, to which they are linked by the nerve-strands of an electric conductor. And thus another step forward is made in the extension of man's sphere of conscious perception.

The New Armor

SOME thirty years ago, when the increasing power of rifled guns had shown the need for armor plate of greater resistance, the makers were confronted with the necessity of providing a plate which was at once both hard and tough. Then it was that the plan was tried of welding a face of hard steel upon a backing of softer metal possessing great toughness. Excellent in theory, the system was found to be very defective in practice, chiefly because of the impossibility of providing a satisfactory weld between the two plates. At the proving grounds, the hard face would split up and break away from the backing. It was realized that in the state of the art, no satisfactory "compound armor," as it was called, could be made. Then came Harvey's brilliant invention, in which the plate was made homogeneous throughout its thickness, and the necessary hardness imparted by carburization of its front face. Krupp improved upon the Harvey process by using gas in place of solid carbonaceous material.

The process of face hardening has always labored under the disadvantage that the super-carburization of the surface could be made to reach only a certain limited depth; whereas the continued improvement both in the energy of the projectile and its ability to hold together while penetrating the hard face, has enabled the gun to once more master the plate. To-day there is a demand for a plate having a much deeper layer of face hardening than is possible by present processes. During the past few weeks, much has been written in the European technical press about a new system of face hardening, known after the name of Simpson, the inventor, who appears to have adopted the Cammell process, but with the important difference that he has introduced a plate whose weld is so perfect that under test, it presents no natural line of cleavage along the line of the weld. It is claimed that this result has been obtained by interposing a thin sheet of copper between the two plates before welding them together.

As in the case of many another important invention, the author appears to have stumbled upon its secret by chance. In the course of some experiments, Simpson found that copper and steel, when subjected to a certain treatment, formed a molecular mixture or solid solution of the two metals. Later, he discovered that if two plates of steel with a sheet of copper between them were placed in a mixture of carbon, brown sugar, and water of the consistency of compressed snow, and the whole mass were heated to 2500 degrees Fahrenheit, the copper melted away into the steel and formed a weld so perfect that not only was it impossible to split the plate at the juncture, but the copper increased the tenacity of the steel. Professor J. O. Arnold, of the University of Sheffield, after making a micrographic analysis of some specimens, stated that the copper seam formed a solution which was micrographically almost indistinguishable from the steel itself. The copper seam is so completely soluble in the steel that it takes a molecular form which is beyond the range of microscopic vision. The weld, in the ordinary acceptance of the term, has disappeared, there being absolute molecular continuity.

Now, the importance of this process, in its bearing upon armor plate manufacture, is evident, since now the thickness of the hard face may be increased to any degree desired. It is stated that already trials have been made with 6-inch plates, in which two inches of hard steel were welded upon four inches of soft backing, and that the plate, under attack by a 6-inch gun, gave very satisfactory results. If, as is claimed, the resistance of a given weight of armor has been raised from 20 to 25 per cent, it follows there is that additional percentage of a given weight of the present armor available to the designer, for improving the offensive or defensive qualities of a warship. He may increase the defensive qualities of his ship by retaining the present thickness of plate, or he may reduce the thickness of his armor and put the weight thus saved into a heavier battery or into more powerful engines, or into a larger coal supply. Probably, in view of the more powerful guns which are being mounted in the world's navies, he will choose the first-named alternative—for it is certain that, at the present time, the gun seems to have the ship at its mercy.

Octave Chanute

His Work and Influence in Aeronautics

By Dr. Albert Francis Zahm

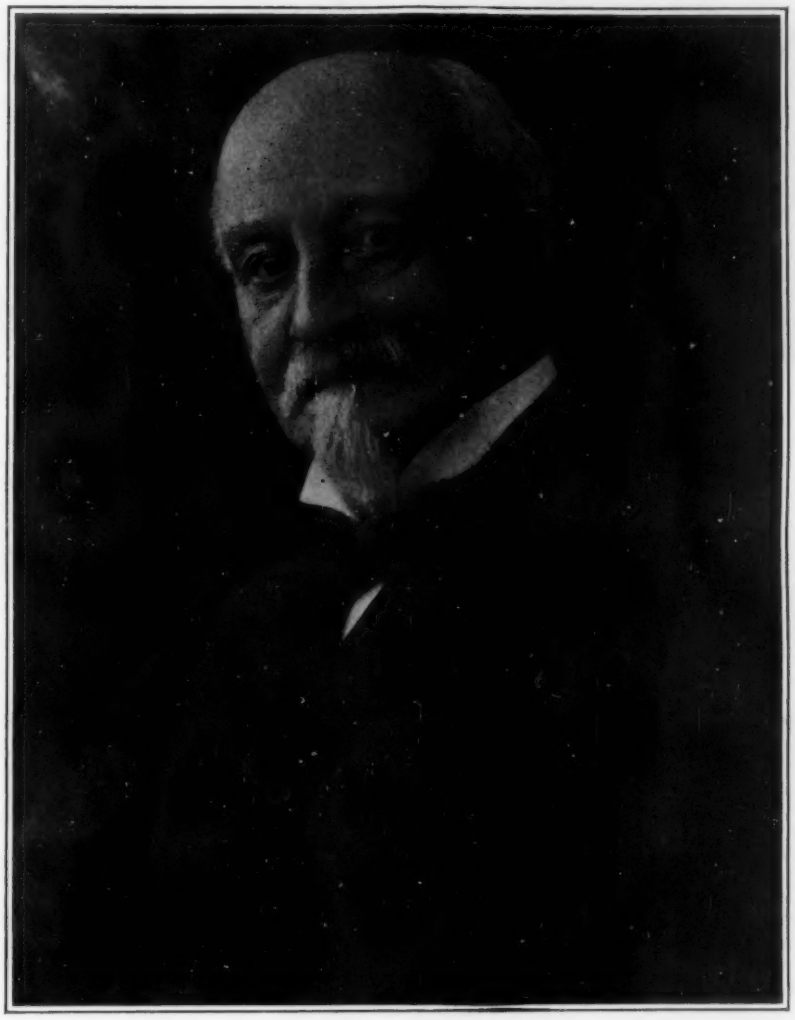
OCTAVE CHANUTE, who is sometimes called the "Father of Aviation in America," did much to merit that title. He and Langley were the deans of the pioneers of mechanical flight in this country. He promoted the art by numerous and judicious publications, lectures and scientific congresses. He was the sympathetic and helpful friend of practically every earnest and prominent student of aviation in the world up to the arrival of the first successful aeroplanes. He made fundamental experiments and inventions by which he achieved practical gliding flight and led other experimenters in America and Europe on the direct and easy way to dynamic flight, by application of the gasoline engine to the Chanute glider.

Born in France in 1832, he came at the age of six to New York, where he was educated, and at the age of seventeen began his lifework in civil engineering on the Hudson River Railway. Later he went to the middle West, where he superintended the building of many railways, bridges and terminals, and finally, 1889, established himself in Chicago as civil engineer and president of a wood-preserving company. Though he became one of America's foremost engineers, he was from early manhood an enthusiastic student of aviation, so much so that it required all his force of character to put aside those studies till he had first acquired a competence and some leisure. Finally about the beginning of the last decade of the nineteenth century, when Maxim, Langley, Lilienthal and Hargrave were making their famous experiments in aviation, Mr. Chanute emerged cautiously from his studies, and was quickly recognized as the first authority in America, both in balloons and flying apparatus.

In 1890 the present writer, while a student of mechanical engineering at Cornell University, heard Mr. Chanute lecture there on aeronautics, and was introduced to him, then a silver haired gentleman of fifty-eight, full of faith in the art, but apologetic enough for identifying himself with a pursuit so generally contemned. A few months later, Mr. Chanute accepted with unfeigned trepidation the chairmanship of the Third International Conference of Aerial Navigation, to be held in Chicago during the exposition of 1893, and immediately began, with characteristic energy and method, to have papers prepared on every topic of aeronautics and the allied sciences, by the foremost writers and experimenters in that science throughout the world. Though he suffered not a little raillery from his brother engineers for his interest in an "impossible" art, he pointed with some elation to the forty-five papers presented by the industrious members of this congress, the first of its kind held in America. In 1894 he edited the proceedings of the conference, and at the same time published in book form his valuable series of articles in the *American Engineer and Railway Journal*, under the title of Progress in Flying Machines, a careful and discriminative work of more than one hundred thousand words devoted to the elementary principles of aviation, and to a critical history of all the most interesting and ingenious attempts to compass mechanical flight by means of apparatus heavier than air —kites, dirigible parachutes, gliders, toy flying machines, helicopters, orthopters and aeroplanes.

This was really Mr. Chanute's graduating thesis in all that was known in aviation at that time. He was now publicly and irrevocably identified with aeronautics; he was in constant correspondence and conference with numerous votaries of the science in many countries; his ample library was banked with aerial literature, and hung with soaring birds and gauzy-winged aeroplanes. He was a gentleman of means and of some leisure; he was definitely committed to aviation; he was proficient in the art; he therefore determined to embody some of his dreams in palpable form.

In his opening address before the Conference on Aerial Navigation, Mr. Chanute expressed the belief that a dynamic flier could then be built, if men wished to risk their money without too much hope of a return. He even estimated that a one-man aeroplane could be made for twenty thousand dollars. The two main difficulties seemed to him to be the securing of a suitable motor, and the manipulation of the machine in flight. Mr. Mosher, of New York, offered to build a steam engine of one horse-power weighing ten pounds, for ten thousand dollars, and a larger engine of like type for a larger sum. This seemed to answer fairly well for a first demonstration of the feasibility of mechanical flight, and accordingly Mr. Chanute gave his attention, for the next few years, to the study of automatic stability, as well as the manual control, of aeroplanes.



OCTAVE CHANUTE

On June 22nd, 1896, accompanied by Mr. A. M. Herring and two assistants, he went into camp among the sand dumes, on the southern shore of Lake Michigan, to study the art of navigating an aeroplane without artificial motive power. Mr. Chanute thought that the maintenance of equilibrium under all circumstances was at that time the most important problem of aviation, and that until automatic stability was secured, it would be premature and dangerous to apply a motor. Otto Lilienthal, in Germany, had made many successful down-hill glides on an aeroplane from which he was suspended by the arms; but Mr. Chanute wished to evade, for he did not relish, Lilienthal's way of balancing by shifting the body and kicking wildly at the stars. His main purpose, therefore, was to acquire the pilot's science; but secondarily he would learn much about the architecture of gliders, the behavior of air currents, the elements of propulsion and sustentation.

He and his assistants made some flights with a Lilienthal monoplane; but, finding this unsafe and treacherous, they discarded it in favor of a multiple-wing glider designed by Chanute, which after many empirical modifications in the placement of the sustaining surfaces, assumed the form of an ordinary multiplane glider of the present day. This glider resembled the Lilienthal biplane in having the surfaces vertically superposed, the rider below them, and the rudder in the rear; but it was a five-decker whose wings, on either side, could swerve fore and aft, so as to bring the center of lift always over the center of gravity, in order to prevent excessive rearing or plunging. This glider was found very tractable in a twenty-mile wind, and in a thirteen-mile breeze would sail down a slope of one in four. After further study, the five-decker was displaced by a three-decker, which presently was deprived of its obstrusive and unessential lower surface, thus assuming the familiar form of the Chanute biplane glider. This was a radically new and elegant design, consisting of two superposed arched surfaces held together by vertical posts and diagonal wires, like a Pratt truss. It was, in fact, the renowned "Chanute glider" which has been copied by so many successful designers of biplanes.

The Chanute glider weighed 23 pounds, spread 135 square feet, and readily carried a total weight of 178 pounds at 23 miles an hour. It was provided with side planes and a double rudder, and this latter was elastically connected with the main body to insure steadiness of flight, on the principle of the elastic wing margins used by D. S. Brown in 1874. This craft was found easy to manipulate in launching, sailing and landing, a two-inch shift of the pilot's weight being equivalent to a five-inch shift on the Lilienthal monoplane. It was steady at a speed of twenty to forty miles an hour through the air, even when the wind was blowing seventeen miles an hour overground. The angle of descent was 7.5 degrees to 11 degrees, depending on the speed and trend of the wind. The work of gravity expended in maintaining steady flight was at the rate of two horsepower for the 178 pounds, a good showing with the rider vertical.

Summer passed before Mr. Chanute could perfect the invention for automatic stability by means of swerving wings; but otherwise the gliding experiments were very satisfactory. The strong and simple biplane evolved during those few weeks of fruitful study was an important contribution to the science of aviation by reason of its strength and simplicity of design, its efficiency, its stability, and, best of all for that day, its record for good flights and safety. All who could appreciate it understood that the addition of a light motor would transform it to a dynamic flyer, navigable at least in mild weather.

A full account of these experiments was published by Mr. Chanute in the Aeronautical Annual of 1897, and in a paper read by him before the Western Society of Engineers in the same year. This paper stated that the experiments were promising, and invited other investigators to improve upon them. Presently other persons in several countries did improve upon them, notably the Wright brothers and Montgomery in America, the Voisin brothers, Ferber and others in Europe.

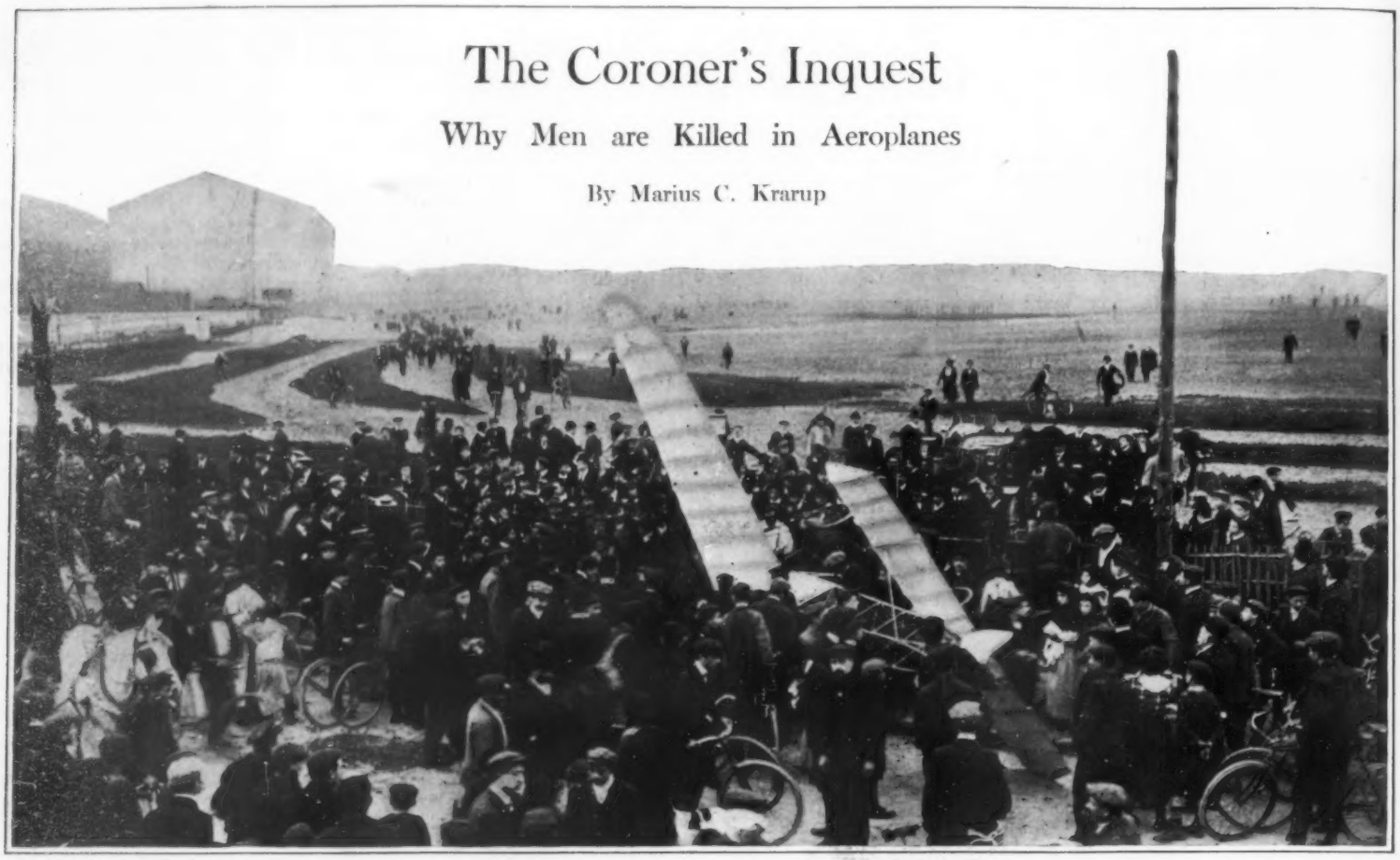
In March, 1900, one of Mr. Chanute's earliest disciples, Wilbur Wright, wrote inquiring of him as to the construction of his machine, the best materials to be used, the most suitable place to experiment, etc., saying that he had notions of his own that he wanted to try, and that he knew of no better way of spending his vacation. All that information was gladly furnished, and the two men became fast friends.

(Continued on page 488.)

The Coroner's Inquest

Why Men are Killed in Aeroplanes

By Marius C. Krarup



IN part a flying machine and in part a death trap, the aeroplane has done both more and less than its sudden arrival among the great inventions of the age had promised. The very assurance of a brilliant future for machines of its kind, which has been produced by its performances, renders it necessary that its defects be remedied and its failures obviated.

This combination of a Chinese or a box kite, an automobile motor, a restaurant fan, balloon rudders, junior bicycle wheels and ski runners, the whole strung together with piano wire and safeguarded with adhesive tape and mammoth rubber bands, sprang from toyland into the world of industry, politics, warfare and finance when two plodding and practical tinkers of genius—self-made engineers from the American school of try, try and try again—proved they could balance and steer it by a twist of its muslin. Then, all could fly. Any kind of a kite, with any style of gasoline motor, with the fans pulling or pushing their blades of varying number, with rudders fore or aft or both, large or small, with keels, horizontal or vertical or both, or without any keels—just so the total weighed within limits—could be made to rise from the ground and travel on the wavering roads of the atmosphere. Even the twist of the planes could be counterfeited. Flight with the "heavier-than-air machine" was an accomplished fact. All minds turned to flight, to exploit or to improve the aeroplane, or merely to wonder at its possibilities. In three short years, by improvements in its component parts and the training of many aviators, but without the addition of a single new fundamental idea to supplement or correct its original design, it has been developed to the point of carrying a considerable load of fuel, lubricating oil and humanity for eight consecutive hours, while coursing over a distance of 350 miles without once seeking the mother earth. It has fanned itself and its burden—going up at an easy incline, as the crane flies when rising from the marsh—up into the thin air two miles above its starting point, where the aviator gasps for breath and the throat of the carburetor chokes with ice, and has slid down again on the spiral bannister which its own twisted planes shaped in the atmosphere. It has sailed over arms of the sea and over the gruesome glaciers of the Alps. It has transported passengers from the capital of one empire to the capital of another, and back again. It has circled over fortifications and battleships and has brought home photographs of the panoramas which spread beneath its course. While flying with it, men have sent and received ether messages. It alights on water or on shipboard and flies thence home again. Four, five and six persons, and recently even twelve, have clung to its spars while the fan blew the whole ton-weight from town to village, an ordinary half-day's journey.

But between-times it has exacted sacrificial offerings to the demons of the atmosphere. Without hint or warning it has often suddenly refused to heed its rudders and has dropped as a shot bird, anywhich side foremost. Hundreds who trusted the plan of its designers and their own skill have fallen back to earth, as all know, to lie on a couch of pain for months and rise finally with all fine frenzy for flying crunched out of their bones. Monuments have been erected over the graves of twoscore of young men who had thought the air was conquered, and that it was only for them, lucky Aladdin boys, to gather laurels and rewards for demonstrating the victory.

Now, the world turns a searching glance upon this machine which does so much and fails so treacherously. What explanation is offered by the authors of the construction in its various forms, the Wrights, Blériot, Henry Farman, Curtiss, Levavasseur, Esnault-Pelterie and Louis Bréguet? What do they say, not with their lips, but through those actions which interpret thoughts the tongue scarcely knows? Though all brave and brainy, they all fly, now, just as rarely as compatible with leadership in progress. No other invention designed for sport and transportation work, and launched as complete and full-fledged, was ever so readily turned over for others to enjoy. None was ever so sparingly used by those who knew it best.

What does the engineer say, the man whose profession it is to compare the creations of inventive genius with the data of applied science, to take note of their imperfections and to contribute to their rational development? What structural peculiarities does he find which aeroplanes have in common and in which he detects violations of established engineering rules, whose validity no invention can change? If deaths are due to plain and indisputable engineering errors which might be avoided, the engineer should be a good man to have on the coroner's jury, when public opinion or sentiment chooses to impanel itself in that capacity. Limiting himself to facts which are not disputed and to conclusions whose correct derivation from the facts all may check without special technical knowledge, the engineer finds about as follows:

The preservation of equilibrium in a disturbed atmosphere depends upon control action by the aviator. The means for control are (1) twisting of the main planes or wings, and (2) operation of horizontal and vertical rudders. Both the twist and the rudder action are required. One supplements the other in most instances. Both must be reliable, if equilibrium shall be preserved under all circumstances. Even if twisting of the planes (or the almost equivalent manipulation of *ailerons* or wing-tips) is assumed to constitute a reliable method for obtaining certain indispensable effects, the fact that this method is not sufficient for all purposes makes it certain that the preservation of equilibrium still depends ultimately upon the reliability of rudder action also. The facts relating to rudder action must be examined.

The efficiency of rudder action depends, other things equal, upon the speed of the structure to which the rudder is attached. A drifting ship or a drifting balloon does not obey a rudder. The movement of the structure must be in the direction of its axis. Any deviation from this direction changes the neutral position of the rudder, and for this change the operator must immediately make allowance as best he can. It also affects the resistance against the progress of the structure, changing it from one equally divided on both sides of the axis to one unequally divided, and the rudder action is frequently not powerful enough to compensate for this inequality. In the case of an aeroplane, neither the speed of the structure nor its direction is assured. True, it makes no difference that the whole machine may be carried sideways in relation to things on earth. Generally, only the relations to the surrounding atmosphere are of consequence, in so far as the obtaining of certain effects from certain control movements is concerned. But, sooner or later, an atmosphere current or eddy strikes with more than usual force one of the wings or one side of the planes, while other portions remain, for a moment at least, subjects to different influences. Birds, by their small dimensions, practically escape this difficulty. Then, if the disturbed position given the whole machine is one so much inclined that the planes or winds fail to give their usual support, gravitation and the new lateral tilt of the planes enter as new factors in the play of forces and pull the machine away, in higher or lesser degree, from that axial direction of its movement which is ordinarily maintained by the propulsive power. The rudders no longer act as intended. Position control is lost at a moment when most needed, although skill in allowing for the misalignment and suitable twisting of the panes (or turning of *ailerons*) may obviate catastrophe when the disturbance is not too severe. The much smaller difficulties experienced in steering a ferryboat when its bow is in one current of water and its stern in another illustrate a parallel but less complicated and serious situation. Were boats in danger of going to the bottom of the ocean every time they fail to obey the helmsman, rudder-control would have to be abandoned for them, too.

The obvious fact that either wing, being of much larger area than a rudder, may easily become subject to forces in the atmosphere of much greater magnitude than any which the speed of the machine can

bring to bear on the small rudder area, is in itself sufficient to compel the same conclusion; namely, that control by rudders is unreliable in any but a relatively still atmosphere, and that the adoption of rudder action for control is mainly responsible for the death-list of aviation.

The measure of control which may be exercised by twisting of the main planes or wings is not subject to the same objections, as it is effected through a readjustment of the same large surfaces which are attacked, and not by attempting to influence the course of large disturbed surfaces by counter-movements of much smaller ones. But this adjustment by twist is in existing aeroplanes of small scope and of insufficient variety, always coupling increased resistance with increased lift on one side of the machine and with reduced resistance and reduced lift on the other. Intrinsically, however, the possibility is presented that the adjustment of the main planes which at present takes the form of a slight twist of their surfaces, may be developed by inventive talent into larger and more varied control movements, causing more pronounced changes in the shape and position of either side of the planes and effectually counteracting severe disturbances of the equilibrium.

The engineer notes, further, that propellers of aeroplanes, though they receive all the motor power, deliver only a small percentage of it in form of propulsion. He knows that this is so, without resorting to tests or calculations. A simple observation tells him. Aeroplanes of 40 horse-power or more can notoriously make no headway against a steady wind blowing at the rate of 50 miles per hour, but an automobile with limousine body can be driven against the same wind by the application, at the rims of the driving wheels, of not more than 6 horse-power. And the air resistance against a limousine is, according to the best tables—areas and their angles of incidence being considered—comparable to the resistance which an aeroplane of ordinary size must overcome, at similar speed. Calculations based on the draw-bar pull of aeroplane propellers also indicate a poor utilization of the motor power.

It has been aeroplane practice to seek stronger propulsion by striving for higher motor power, but, according to rules for good engineering, it is the efficiency of the propellers which by all means should be increased, since excessive waste in the mechanical transmission of power cannot be conceived as permanently acceptable. On the other hand, the fact that flight is possible with so much of the power thrown to the winds, literally speaking, seems to shed a strong light on the brilliant results which may be expected from aeroplane construction, when this enormous waste shall have been gradually removed. At the present moment, even a slight improvement in the efficiency of propulsion would mean greater safety, as it would increase the effect of every control action, while, on the other hand, increased motor power means either increased weight or increased liability to motor troubles. Propellers of the present style also reduce safety by hindering speed when not revolving, as when the machine is gliding to earth with the motor stopped.

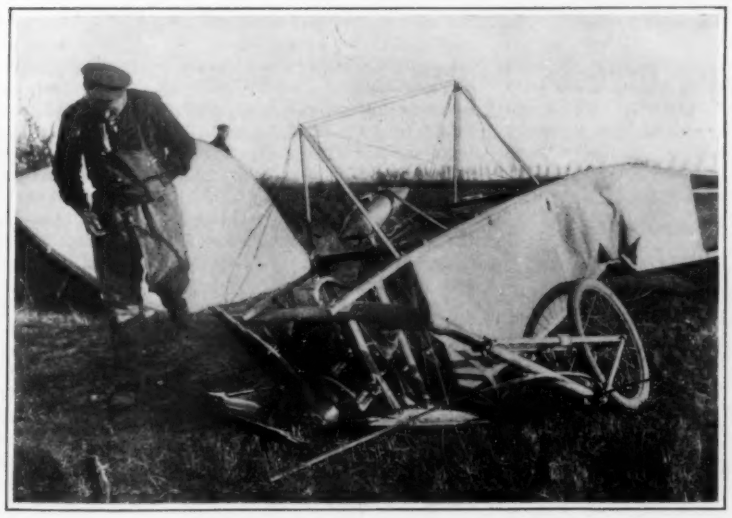
What becomes of the power of the aeroplane motor? It seems that the waste must take the form of heat imparted to the air by friction with the propeller blades and dissipated in the atmosphere.

One more vital fact is observed. No provision is made in the majority of aeroplanes for tempering the jolts received from gusts of wind or eddies. While air is highly elastic, the fact that its irregular movements are frequently so violent as to turn an aeroplane machine completely over, exactly as a hole or a boulder in one side of the road may upset a rapidly-moving vehicle, shows conclusively that the natural elasticity of the disturbing element itself is insufficient under the circumstances, the resistance of the machine against any force tending to upset it being very small. As the "boulders of the air" cannot be circumvented, being invisible to the aviator and also liable to overtake him, a spring suspension for aeroplanes, to protect against "road shocks," as vehicle springs protect automobiles, seems to the careful engineer even more strictly necessary than similar provisions are acknowledged to be for vehicles moving over solid roads. In point of fact, provisions of this nature, in the form of elastic wings, are incorporated in some aeroplanes, notably the Brégueț, the new Paulhan machine and the latest Esnault-Pelterie, and these are yet to be heard from in accidents, though no engineer would expect to be able to proportion the spring elements correctly without considerable experimenting.

The consulted engineer of the coroner's jury has finished his remarks. The members smile a little, and one says to another: "Well, rudders are not much good, it seems, for any machine that you can fall down from and break your bones, but, so far, they have not been able to find anything better, so what are we going to do about it? We cannot stop progress. Suppose we recommend that inventors work a little harder and invite imitators to retire from their pernicious activity. Will that do? Agreed? All right." Verdict: "Nobody guilty, but aviators should not fly when the wind blows, until inventors have found some way of getting away from rudders."

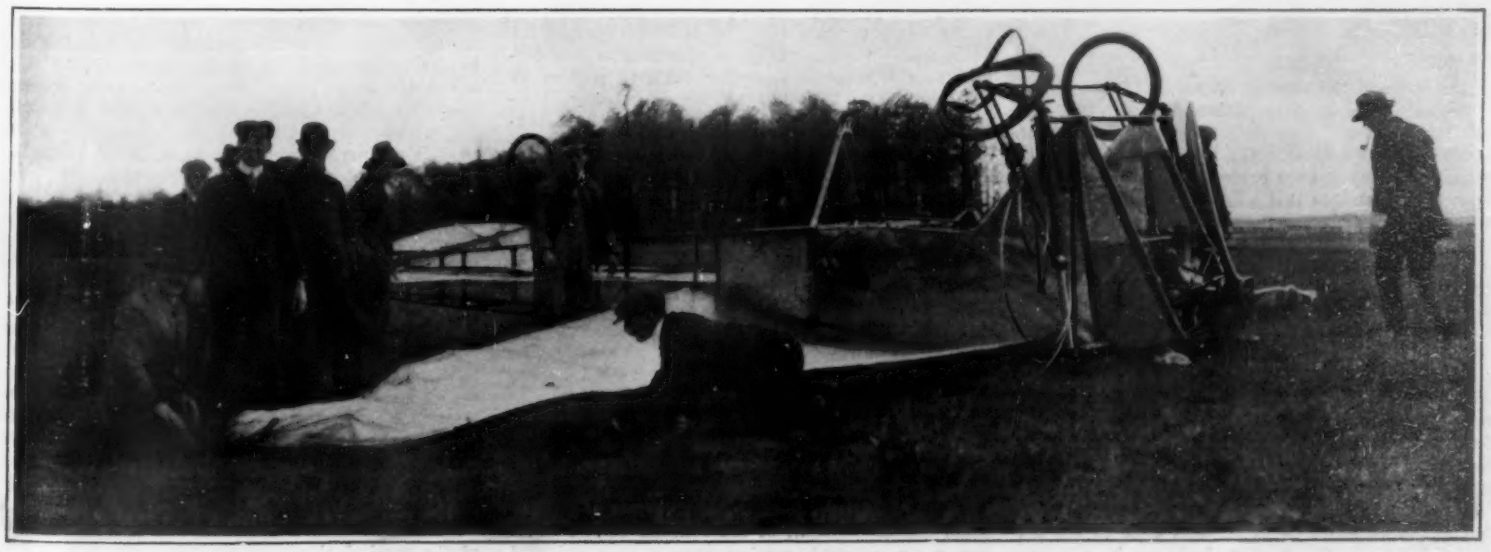
The New British Meteorological Office

THE British Meteorological Office, which for more than forty years had been installed in cramped and unattractive quarters in Victoria Street, London, has recently moved into a new building especially designed for it in Exhibition Road, South Kensington. The transfer of the staff was completed November 15th, 1910, and on December 1st the Meteorological Committee, the governing body of the institution, held an "at home" in the new premises. The building is shared with the South Kensington Post Office, which, in accordance with the English custom, is also a telegraph office, so that the meteorological service now has all the facilities under its own roof for receiving and dispatching promptly its telegraphic reports, mailing its daily weather maps, etc. A noteworthy feature of the new installation is a permanent exhibit illustrating the work of the office and meteorological work in general; a feature that the director, Dr. Shaw, hopes will have the effect of stimulating the interest of the public in meteorology, and lead to the recognition of the importance of including this subject in school curricula.



Propellers make poor plowshares.

There is too often death in "the dive."



Back somersaults mean broken wings.

THE WAXEN WINGS OF THE MODERN IKARUS

The Dirigible of To-day

A Review of French, English, and German Airships

By Carl Dienstbach

THE unfortunate mishaps of large dirigible balloons in recent years, among them Count Zeppelin's leviathans, the French dirigibles "Patrie" and "République," and the German airship "Erbsloeh," have aroused an unfortunate prejudice against the lighter-than-air craft. Accidents, however, are as unavoidable in the experimental development of the airship as of the aeroplane. At the end of 1910, about 1,300 aeroplanes had been tested in France alone, with the familiar frequent results. Because the crew of an airship is more numerous than that of an aeroplane, the destruction of life, when it does occur, is necessarily more appalling. For all that the total loss of life which has resulted from aeroplane accidents far exceeds the number of casualties that may be laid to the door of the dirigible.

The Remarkable "L. P. VI."

In Germany at least the dirigible seems to have been brought to a pitch of perfection hardly realized in this country. The "L. P. VI.," built on the non-rigid Parseval system, was in practically continuous service for over six months before it met with an accident. Hardly less advanced are the rigid Zeppelins. Military semi-rigids in Germany now make almost daily trips.

Probably the Parsevals are the most highly developed airships of the day, because they have been directly evolved from the old spherical balloon. The crack ship of the Parseval flotilla is the "L. P. VI." That vessel has the same dimensions as the passenger-carrying "P-III.," which ascended almost daily at the Frankfort Exposition of 1909. The car has been lengthened so as to provide an increased amount of structural stiffening for the gas bag and more commodious quarters for the passengers. The "non-rigid" propellers have been slightly stiffened and are now "semi-rigid."

Leaving Munich at 10:30 A. M. on October 10th last, the "L. P. VI." landed at Plauen at 4:30 P. M., and remained there until the following morning. At 9:40 A. M., on October 11th, the vessel re-ascended and alighted at 12:22 P. M. near Bitterfeld, where the Parseval shed was entered. On October 12th the ship rose at 11:52 A. M. and landed at 4 P. M. at its Berlin station, despite a head wind of eleven miles an hour. Throughout the entire journey, easterly winds were encountered, in spite of which an average speed of 26 miles an hour was maintained for the whole distance of 346 miles. When it is considered that the sea speed of some of our fastest steamers is not more than 22½ knots, the performanee is truly remarkable. More remarkable, however, were trips made in the Bavarian Alps under conditions which proved that the day of practical aerial navigation has really dawned. A course was followed through narrow valleys in winds as irregular and swirling as the water currents along a rocky coast. "Strong vertical currents," "squalls with fog," and "eddies," all duly recorded in the log, were also encountered and successfully overcome.

The only dirigible which can be compared in regularity of service with the Parsevals are the semi-rigid military Basenachs. Their records, however, are not as yet quite so free from accidents.

Some of the Leading European Types.

The huge French ships "Clément-Bayard II." and the "Morning Post" were built largely as a result of popular English opinion. The "Morning Post" has a capacity of fully 353,000 cubic feet, and was at the time the largest ship that was ever constructed, with the exception of the rigid Zeppelins.

The German non-rigid "Krell I.," a giant constructed by the Siemens-Schuckert works, of 459,160 cubic feet capacity, has outdone the "Morning Post." The craft was avowedly built for military use only. Intermediate between the "Morning Post" and the "Krell I." will be the newest Italian military dirigible, with a displacement of 282,560 cubic feet. Other remarkable craft are the "Capitaine Marchal" (named after the "République's" unfortunate commander), which displaces 254,304 cubic feet, nearly three times that of the "République." The experiences of military service evidently made large size desirable.

As a general rule, the French have paid more attention to the construction of airships than to the art of handling them. During last year's military maneuvers, some of their dirigibles had narrow escapes. M. Capazza, one of the most experienced of French air captains, piloted the "Morning Post" on her memorable trip to England across the widest part of the English Channel. He has publicly expressed admiration and envy of German airmanship. With the exception of the small "Zodiacs," the French military airships are rarely used to the extent that one would expect.

In England airships have been developed by the army on a small scale. As a sea power, England is naturally concerned with the development of the airship as an auxiliary arm to the navy. Big though they were from the very outset, the Zeppelins have grown from 59,160 to 706,400 cubic feet capacity. The British naval dirigible begins at the latter figure.

The latest passenger airship built for Belgium by the French Astra Company, the "Ville de Bruxelles," displaces about 282,560 cubic feet. The most advanced experimental types, the German "Krell I.," and the British "N-I.," were designed primarily for military purposes. Although the French, who really invented the motor-driven dirigible, have not developed lighter-than-air craft as systematically as the Germans, they have produced ships which prove that the designers of the "République" have progressed with the times A French company (Compagnie Générale Transaérienne) has even successfully operated a small commercial passenger airship for the last two years at Pau, southern France, during the winter, and at Lucerne, Switzerland, during the summer.

It is hardly necessary to discuss the comparative merits of the so-called non-rigid, semi-rigid and rigid systems. The very largest sizes will always be rigid. For the smaller sizes, every system has its own advantages and disadvantages. England and France now have rigid ships as well as Germany.

A most interesting construction is that embodied in the "Ville de Bruxelles," the latest Astra type. The single large front propeller of the classical "La France" is still retained; but the "Clément-Bayard II.'s" two elevated side propellers, somewhat reduced in size, and driven by a second motor, have been taken over from the "Clément-Bayard I." The result is that the ship remains under control even after the front propeller is stopped in landing. In the "Ville de Bruxelles" the Parseval shape of hull will also be found, characterized by a blunt, ovoid bow.

The Elaborate Equipment of the Big Airship.

The increased size of present airships has already tended to greater refinement of detail. Donkey engines are becoming common. Brucker's trans-Atlantic "trade-wind ship," the "Suchard," is thus equipped, and so is the "Krell I." The gas bags of both rigid and non-rigid dirigibles are sub-divided into compartments, like a ship, the construction having been first introduced in the rigid Zeppelins. Multiple ballonets are also being adopted in greater number. The good features of one ship are copied in another. Thus we find that the English Zeppelin ("N-I") has adopted the propeller mounting of the "Krell I.," the object being to save long transmissions. In shape it also approaches the non-cylindrical ship. The Zeppelin form, however, still remains essentially cylindrical.

The larger the ship the more elaborate may be the equipment. Wireless telegraph apparatus is now carried by the Zeppelin passenger ships as well as by military craft, so that the navigator may communicate with meteorological stations and keep himself informed as to the weather. Some extremely valuable experiments have been made by the Zeppelin Company in the effort to safeguard their craft from atmospheric electricity.

Preventing Accidents.

Indeed, the Zeppelin Company sees to it that it is impossible for the same accident to occur twice. Thus, the new "Deutschland" has an increased dynamical lift, an improvement that was made immediately after the disaster to the old "Deutschland." As a result, the new "Deutschland" rose to a height of 3,800 feet without casting ballast overboard. Probably the Zeppelin type would be still better if it had a continuous "hold" like the Spiess, containing the motors and the crew, in place of two cars, which are really a legacy of the old spherical balloon. Adherence to type has hampered the development of the airship just as it hampered the development of the railroad car. Just as the early railroad coaches were merely enlarged horse-drawn coaches, so the modern dirigible, in a sense, is still an enlarged, elongated spherical balloon equipped with a motor. Obviously, an airship should have the same unbroken lines below as above, to insure speed. Even semi-rigids and non-rigids could be built more or less after the plan of the Spiess. The use of cars, in other words, the concentration of the load at a few points, is justified in smaller dirigibles, because motors are used in heavy units to insure reliability.

Weather reports are now so important to the airship captain that the German government is beginning to take a lively interest in aeronautic meteorology. The Frankfort harbor has its own aerological observatory, situated in the Taunus Mountains. The government weather service has recently provided many of its stations with the necessary apparatus for measuring the strength and direction of the wind at various heights.

Handling a Dirigible in the Air.

The long period of apprenticeship required in the construction and piloting of a dirigible, a period which is longer, strange as it may seem, than in the case of an aeroplane, accounts for the slow development of the types with which we are familiar.

Although the army experiments almost daily in the air, the tactical handling of dirigibles is still shrouded in mystery. No doubt there are definite rules to be followed, but what they are we can only guess. In the army, night trips are frequent. The airships are formed into squadrons and their pilots taught to maneuver in various formations.

In the popular mind, an airship is a kind of aerial steamer, simply because it is propelled by engines. In truth, it is more like a sailing vessel in its inability to cope with unusual winds. Fifty years ago, when Cooper's sea tales were the "best sellers" of the day, and the reading public was consequently more familiar with navigation than it is now, the principles of the dirigible would have been better understood than they are at present. Indeed, the true story of the "Deutschland's" disaster of last year equals in romantic interest the most fascinating pages of "The Pilot" or "The Red Rover." It must have been a tense moment when the great airship was held motionless against the storm by the full power of her motors, her commander fearing to turn her nose toward safety, because of a black and yellowish bank of clouds that loomed up in that direction. His anxiety can be imagined when the gages of his fuel tanks showed how rapidly his supply of gasoline was falling.

Count Zeppelin himself pointed out that, dependent though it is on wind and weather, there are times when the airship may outspeed the fastest express train between two cities. He admitted that for the return trip he might prefer the railroad to the airship, to avoid a head-on wind. Some day we may hope to see giant airships plowing their way through the air with as much indifference to wind and weather as a modern "Lusitania." When that time comes, there can be no doubt that the airship will be always preferred to the dusty railroad car.

To guide a craft through atmospheric disturbances of more or less violence requires exceptional skill. Major von Parseval has said of the competent air captain: "He must know exactly the speed of his ship and of its maneuvering ability. Above all, he must have a nice sense of her responsiveness to her vertical steering apparatus, and be able to estimate her carrying capacity with considerable accuracy." On the trips from Munich, the "L. P. VI." covered altogether over three thousand miles. One trip to the Zugspitze lasted five and three-quarters hours. On one occasion the Crown Prince of Bavaria and Count Zeppelin were passengers. With frequent small injections of fresh hydrogen, the "L. P. VI." had remained inflated and ready for service for fully twelve weeks. Although the gas had deteriorated, the craft successfully passed through the supreme tests of very stormy weather at Berlin upon its arrival there. In a gale of 34 miles an hour, a speed hardly exceeded by the vessel at her best, the Prince and Princess of Sachsen-Meiningen were taken up. Stelling, the captain, made considerable headway by tacking into lulls, keeping the "harbor" well to leeward, ready to return and land at a moment's notice. This was "airmanship" comparable to the seamanship of any of Cooper's heroes. On these occasions, Capt. Stelling took charge of the vertical steering gear, while his first officer, Hackstetter, had the wheel. Three days later the "L. P. VI." had all its gas renewed at the revolving wharf of the big Siemens-Schuckert airship at Dies-

dorf. After that, sixteen passengers were carried with ease on short trips, in addition to the crew. On one occasion the passengers numbered seventeen, the extra man being a stowaway who had hidden under a fuel tank in order to enjoy the experience of cruising through the air. These trips were practice journeys which preceded the great flight to Kiel two days later.

The maritime provinces of Germany have latterly taken as lively an interest in the airship as in the steamship. They have founded a well-organized society which has raised enough money to make Kiel a great airship harbor as well as a haven for steamers. This society chartered the "L. P. VI." The journey to Kiel began under unfavorable conditions, for a gusty wind delayed the vessel. Six passengers booked places at Berlin; four more boarded the ship at Schwerin. Fog and heavy rain made a landing necessary at Bordesholm, near Kiel, but only after it was impossible to see. After the craft arrived safely at Kiel, Stelling received a telegraphic congratulation from the Kaiser. Schleswig, Flensburg, Hamburg, Luebeck, and other towns were visited by the "L. P. VI." during its stay of six weeks at Kiel.

Advertising in the Air.

On her return to Berlin, the "L. P. VI." resumed her passenger trips. On every fair night the vessel has made a trip from Johannisthal to the principal thoroughfares of Berlin. A large square piece of canvas was spread out on each side; outriggers 32½ feet long were equipped with projectors at their extremities; the outlines of the car are traced in incandescent electric lights. The projecting apparatus flashes on the canvas, in letters legible for a distance of half a mile, such legends as "Schulz's Dog Food is the Best," "Blix Pills for the Liver," and "Drink Ulmer Beer." Thirty different firms advertise their wares in this ultra-modern way, with the result that the airship earns about $700 a night, in addition to the passenger fare.

A slight accident, occasioned by the jamming of the gas bag against the airship's shed during a wind (the men, exhausted from overwork in handling the airship, could not hold her), later made it necessary to re-inflate the envelope. The gas, however, needed replenishing, for the airship had not been inflated for fourteen weeks.

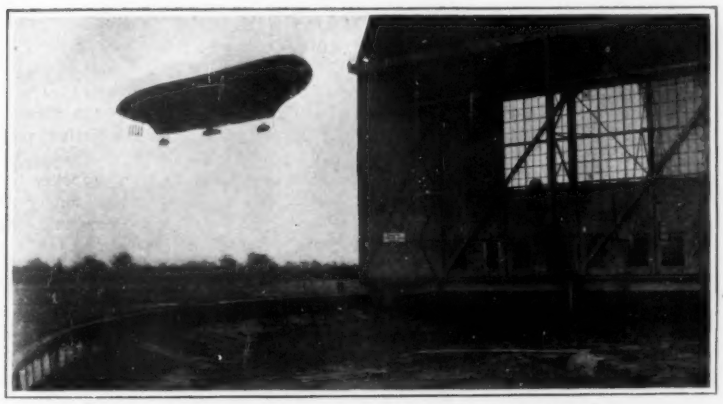
Such is the popular interest in dirigibles that the "sporting" ships of the Parseval class (the "L. P. IX.," of 52,980 cubic feet capacity and 64 horse-power, and the "L. P. V.," of 39,384 cubic feet capacity and 40 horse-power) had all they could do to satisfy the demands made upon them.

Airship Harbors.

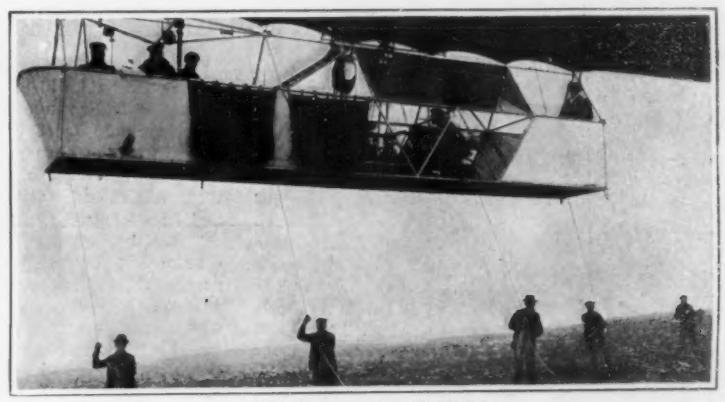
Not only has each new military ship been larger than its predecessor, but the new military air harbors at Koenigsberg and Thorn (fortresses on the eastern frontier) have been constructed to house ships one-half as large again as the biggest vessel now in service. For craft so huge, portable sheds are out of the question. Permanent air harbors must be constructed, which will serve as bases for craft having a large radius of action. These bases, naturally built in fortresses, must be sufficiently numerous and well distributed to meet the emergencies of war. Thus constituted, they form part, as it were, of the active field force and become factors to be reckoned with during hostilities. With the experience of the German airship division in night flying, it would not be difficult for a dirigible to enter or leave a fortress in the dark in safety.

The new Zeppelin harbors are planned on an elaborate scale. To the stations at Duesseldorf and Baden-Baden, others will be added before the summer is over, at Potsdam, near Berlin, Frankfort and Hamburg. Money will be freely spent on these harbors by special companies and municipalities. Besides the harbors mentioned, the stations at Gotha and Kiel will also be available, and in emergencies, the great military harbors at Cologne, Strasburg, Metz, Koenigsberg, Thorn. Smaller cities that cannot afford great harbors with sheds are beginning to establish landing places and moorings. Aerial beacons will soon be common, if we may judge by the experiments made at Spandau and Munich.

At present dirigibles are docked and started on their journeys by forces of trained men. Long practice has enabled these men to handle even such huge craft as the "Krell I." and the new "Deutschland," of Zeppelin, with ease. Lack of practice or caution, on the other hand, may result in accidents, such as that, for example, sustained by Zeppelin's new "Deutschland" at Duesseldorf, and by the "L. P. VI." To cut down the expense which the maintenance of a large body of men necessarily entails, we find that the

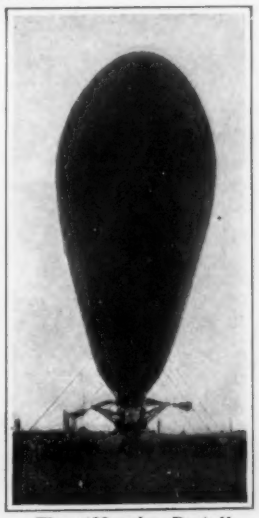


Detail view of the rotatable shed of the "Krell I."

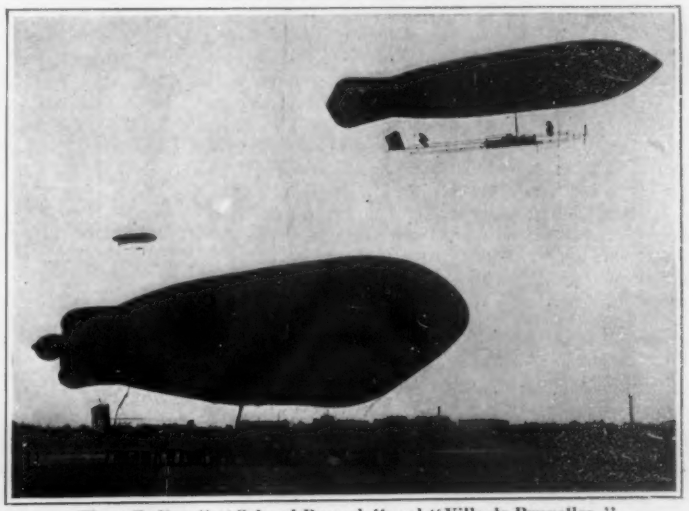


Central car of the "Krell I."

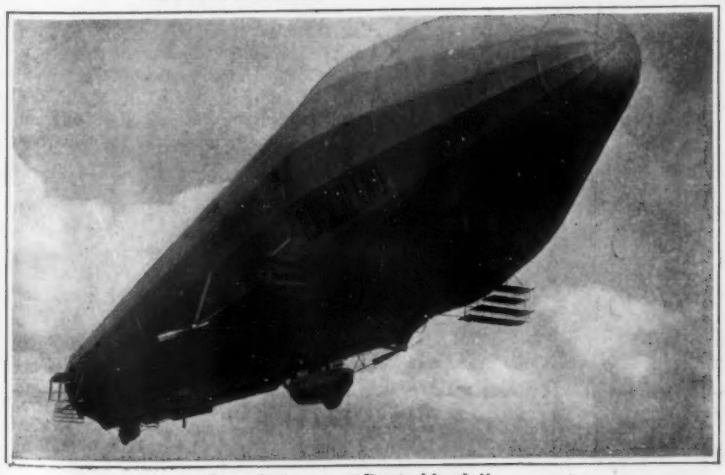
The new Parseval VI.



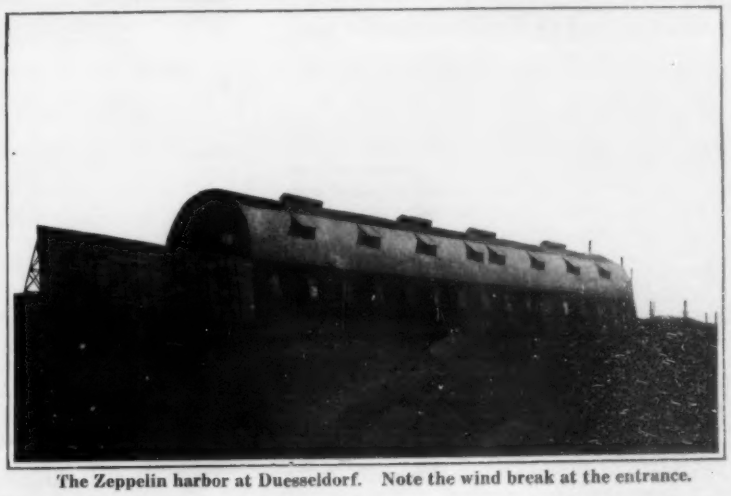
The "Morning Post."



The "Zodiac," "Colonel Renard," and "Ville de Bruxelles."



Zeppelin's new "Deutschland."



The Zeppelin harbor at Duesseldorf. Note the wind break at the entrance.

TYPES OF RECENT AIRSHIPS

"Krell I." is docked partly by the aid of electric winches. No doubt similar devices will be provided in the big new Zeppelin station at Frankfort-on-the-Main.

Just now inventive ingenuity is concentrated on the improvement of the airship itself. The time will soon be ripe for a consideration of the problems here indicated of handling an airship by machinery entirely. Of these problems, perhaps the most serious is the difficulty of anchoring an airship in a high wind. In handling the "Krell I." that problem is almost solved. The anchor cable is led to the nose of the ship and there divided. The twenty-four single ropes into which it finally separates are fastened all around the envelope, where the diameter is no less than 20 feet. The Zeppelin company have had so much experience in landing and holding ships in storms that, in the opinion of Director Colsmen, not a rod would have been bent on the "Deutschland I." had that ill-starred vessel descended in an open field instead of in a forest. It should be no more difficult to handle an airship than a "Lusitania;" but as it is, the "Lusitania" is probably docked with greater facility than any giant dirigible of our day.

Difficulties in Building a Big Airship.

All other difficulties of building large airships are summed up in the well-known fact that as a structure increases in size, the margin of safety does not increase in proportion. In other words, if you desire to build an airship 300 feet long on exactly the same lines as a successful airship 150 feet long, it would be incorrect, from the standpoint of civil engineering, to scale up the parts of the smaller airship to the proportionate size of the larger airship. The big "Morning Post," which is a "Lébaudy" of 353,200 cubic feet displacement, is simply a Lébaudy of 105,960 cubic feet enlarged line for line. There is but a single car, very close to the envelope at that. The smaller ships. It cannot be denied that the "Morning Post's" crossing of the widest part of the English Channel in a strong wind and its journey from Moissons to Aldershot in five hours shows that the size must be very greatly increased before the structural danger point is reached.

The design of the "Krell I." seems to embody the opposite principle, namely, that an increase of size beyond 105,960 cubic feet entails all the resources of a civil engineer to increase the margin of safety proportionately. There are not simply two cars instead of one, but three, so suspended that the pull on the gas bag is all in a vertical direction—very different from the oblique suspension and pull of the "Morning Post." Hence, in the "Krell I." a minimum strain is exerted on the envelope. It is true that the hull of the "Krell I." is uncommonly slender, in spite of the absence of a stiffening frame, on which the "Morning Post" essentially relies. Whatever may be the shape of the hull, the material is subjected to tensile stresses only. From these considerations, it would seem to follow that the "Krell I." will greatly excel the performances of the "Morning Post."

The new German military "M-IV," displacing 35,320 cubic feet more than the "M-III.," is provided with a very substantial stiffening frame. Still, it is so designed that the load is divided in two. Its engine power exceeds greatly that of the "Morning Post." The new Austrian mammoth, "Stagl-Mannsbarth," also has two cars, on "only" 286,092 cubic feet displacement. But that vessel, too, is devoid of a stiffening frame. Count von Zeppelin's second "Deutschland" is considerably lightened without any fundamental change in plan or material because the girders were re-designed more skillfully. The British rigid "N-I.," which is very similar in type, is built of a superior material (Duraluminium), and has been judiciously developed by naval officers. The result is that its engine power is higher, and that its radius of action for the same displacement is probably somewhat greater. Both the new "Deutschland" and the British "N-I" are nearly identical in design with the first Zeppelins of only 459,160 cubic feet. In neither case was it considered necessary to increase the margin of structural safety with the size.

Aeroplane Propellers

By William McEntee, Assistant Naval Constructor, U. S. N.

THE coming of the aeroplane and dirigible has stimulated interest in propellers.

When the Wright brothers had arrived at the stage in their experiments where they desired to fit power to their aeroplane, they very naturally turned to books and theories on marine propellers in determining the kind of propeller to use. Whether it was that existing theories were considered inadequate or that the data was considered incapable of extension to the air is not known, but they have stated that they found it necessary to conduct experiments and evolve a propeller theory of their own for the purpose.

Among naval architects and marine engineers the propeller problem has been, and is to-day, one of the most fascinating and important that they have to deal with. Many will be surprised to learn that among them there is no commonly accepted theory satisfactorily explaining all the various phenomena associated with the action of the propeller nor one that can be used to predict with certainty what a new type of propeller will do under given circumstances.

The marine propeller has been in use for over sixty years; its theory and mathematics have been attempted by many of the world's keenest intellects, including that of Rankine, yet at the present day there can scarcely be a designer who would have the hardihood to say that a particular design of propeller is the best that could be produced for a particular purpose or that some other designer could not beat it by a considerable amount. The truth is that mathematics have not yet advanced to a stage of flexibility such as to permit complete treatment of the subject.

How well the Wrights have succeeded in this intricate and difficult matter may be judged from a simple comparison of the weights of their machines and the motor power required to make them fly. Some of the other well known types of aeroplanes flying at the same speed require from 40 to 75 per cent more horse-power per pound of total weight in the air. This difference in economy is largely due to the superiority of the Wright propellers. The Wrights obtain a propeller efficiency which is equal, if not superior, to that obtained with the most successful marine types. To those who are familiar with the inherent difficulties of propeller design nothing can show more clearly the exceptional practical, experimental, and theoretical abilities which were required to achieve this result in comparatively so short a time.

The two features in which their propeller differs most markedly from those used in other aeroplanes are large diameter compared with the thrust developed and low number of revolutions compared with speed through the air. These two features will be discussed later.

In general, the experience obtained with the water propeller should be capable of extension to the aerial propeller, though the latter differs from the first in an important particular. It has a marked advantage over the first in that it works in a fluid which is practically perfectly elastic, and what is known as "cavitation," or holes in the water around propeller blades, cannot happen in the air. When the phenomenon of cavitation appears in water there is always an undue waste of power. As the result of some experiments made by Langley on aerial propellers, he stated in 1891:

"Notwithstanding the great difference between the character of the media, one being light and very compressible, the other a dense and very incompressible fluid, these observations have indicated that there is a very considerable analogy between the best form of aerial and of marine propeller."

The published data relative to actual results obtained since that time are meager, but so far as they go they seem to bear out Langley's conclusion.

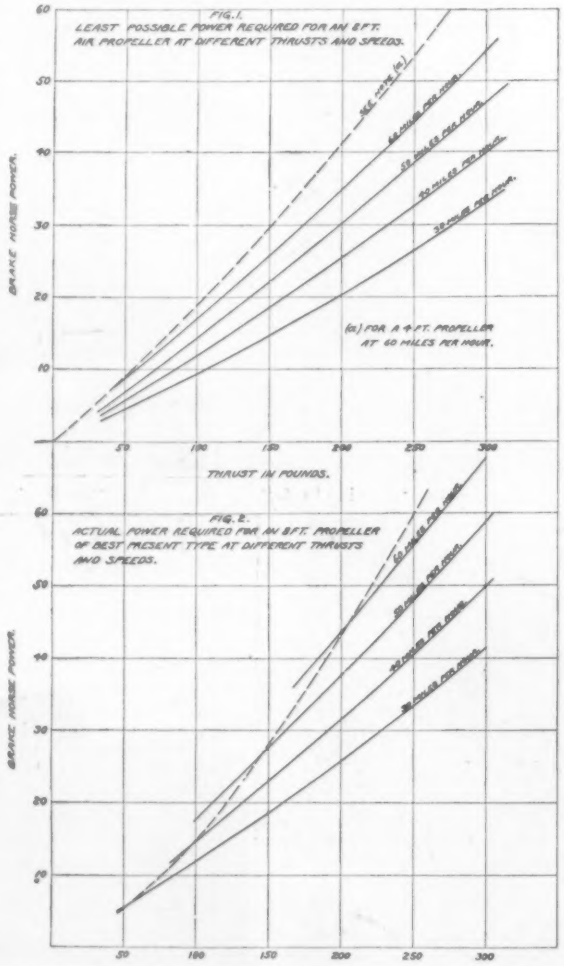


FIG. 1.
LEAST POSSIBLE POWER REQUIRED FOR AN 8 FT. AIR PROPELLER AT DIFFERENT THRUSTS AND SPEEDS.
60 MILES PER HOUR.
50 MILES PER HOUR.
40 MILES PER HOUR.
30 MILES PER HOUR.
20 MILES PER HOUR.
(a) FOR A 4 FT. PROPELLER AT 60 MILES PER HOUR.
BRAKE HORSE POWER.
THRUST IN POUNDS.
FIG. 2.
ACTUAL POWER REQUIRED FOR AN 8 FT. PROPELLER OF BEST PRESENT TYPE AT DIFFERENT THRUSTS AND SPEEDS.
60 MILES PER HOUR.
50 MILES PER HOUR.
40 MILES PER HOUR.
30 MILES PER HOUR.
BRAKE HORSE POWER.

Diagram showing relations of thrust, horse-power and speed for 8-foot air propellers.

The following discussion is intended to give a general idea of the important elements of the aeral propeller and the limiting conditions affecting power, size, and speed:

If for instance it is desired to fit a propeller to an aeroplane weighing with operator and passenger 1,200 pounds, and requiring a thrust of 200 pounds to make a speed of 40 miles per hour with a motor of 30 brake horse-power, it is of considerable advantage if there are means available to indicate that the result cannot possibly be achieved by using one 4-foot propeller; for in this case time and money will not be wasted in an effort to accomplish something which is impossible. If also there are means at hand which will indicate that this end can probably be more easily accomplished by the use of two 8 foot propellers or one 11¼-foot propeller, it will be possible to get a satisfactory propeller in quicker time and at less expense.

Diameter.—One of the first matters to determine is the diameter or size of propeller to use in order to obtain the required thrust without undue expenditure of power. The diameter is a very important element. The thrust or push of propeller ahead is the reaction it receives from thrusting or pushing a quantity of air to the rear. The air acted on at the propeller is limited to that which flows through a circle described by the tips of the blades. The quantity of air acted on therefore increases with the diameter, and as the thrust depends directly on the quantity of air and the velocity at which it is displaced to the rear, it follows that the greater the diameter the less rearward velocity need be imparted to it to obtain a given thrust. Thus approximately the same thrust will be obtained from an 8-foot propeller which imparts a 5-mile velocity to the rear as from a 4-foot propeller which imparts a 20-mile velocity.

Many, of course, know that of the total power developed by an aeroplane motor but a part is actually used in pushing the machine through the air, the remainder does no useful work, and is lost. A considerable portion of the lost power or energy is contained in the air which has been pushed to the rear by the propeller. The amount of such lost power increases as the square of the velocity at which it is pushed astern.

In the case of the 4-foot and 8-foot propellers compared above, we should find that when developing the same thrust at a speed of 40 miles per hour, this lost power for the smaller one would be about three times as great as for the larger one. That is the underlying reason why small propellers are inefficient when used to develop relatively high thrust. A better appreciation of the principles involved in this will be had by those who have happened at some time to lose their paddle or oars from a canoe or boat and been compelled to paddle to shore with their hands. Though they worked possibly harder than before, the effect obtained was mostly in pushing small quantities of water astern rather

than propelling the boat ahead. Their propeller was too small.

In order to get thrust from a propeller it is absolutely necessary to waste some power, because it is necessary to thrust at least some air to the rear. The least amount which it is necessary to waste can be figured out, and this added to the useful power gives the *least possible* amount of power which would be required with a perfect and frictionless propeller.

The curves in Fig. 1 show this least power for an 8-foot propeller at different thrusts and at speeds of from 30 to 60 miles per hour.

At a matter of fact no propeller can be expected to reach the theoretical limit. In water for the best type of propellers about 25 per cent more power is required than that indicated as necessary by theory. The best air propellers require about 25 per cent more power than that shown by the curves in Fig. 1.

The curves in Fig. 2 show the power which will be needed for a good type of propeller, which if attained should be considered satisfactory at the present time. These curves have been prepared by adding 25 per cent to the theoretical power required in each case. For example, from these curves at a speed of 40 miles a thrust of 100 pounds should be obtained with 14.7 brake horse-power. The Wrights get this thrust with about 15 horse-power, which is in practical agreement with the above.

In Fig. 1 the dotted line shows the minimum power theoretically necessary for a 4-foot propeller at a speed of 60 miles and at different thrusts. At a thrust of 200 pounds 41 horse-power is necessary, while for an 8-foot propeller only 35 horse-power is required; that is, at this speed and thrust the smaller propeller requires 20 per cent more power than the larger one.

From the above it appears that the larger the diameter the better, and this would be true but for friction and head resistance of the air to the propeller blades. This increases as the diameter is increased, and the power lost from this cause soon becomes as great or greater than that carried away by the air in the propeller race or wake. With other conditions equal and developing the same thrust, an 8-foot propeller will lose from frictional and head resistance about twice as much power as a 4-foot propeller.

Relation Between Diameter, Speed, and Thrust.—It has been shown that if the diameter is made small there is excessive loss of power in the propeller race, or air pushed to the rear, and if it is made too large the frictional losses are excessive. The best size is between the two extremes.

In water it has been found that when cavitation does not occur, about the best diameter is given by the formula $d = \frac{\sqrt{T}}{V}$ where d is the diameter in feet, T the thrust in pounds, and V the speed of the vessel in knots.

If allowance is made for the difference in the weights of a cubic foot of water and a cubic foot of air, and the speed is changed from knots to miles per hour, the corresponding formula for air propellers is

$$d = \frac{33\sqrt{T}}{V}$$

For a thrust of 100 pounds and a speed of 40 miles per hour the diameter would be

$$d = \frac{33 \times \sqrt{100}}{40} = 8\tfrac{1}{4} \text{ feet.}$$

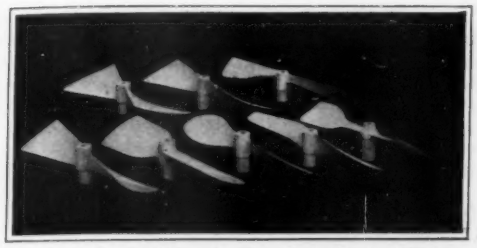
This agrees remarkably well with the results obtained by the Wrights, who use an 8½-foot propeller for this thrust and speed.

The dotted line in Fig. 2 shows this relation for an 8-foot propeller. This line crosses the power curve for a speed of 60 miles at a thrust of 210 pounds, and that should be the thrust of about the best efficiency. At a speed of 40 miles the best efficiency would be obtained with a thrust of about 95 pounds.

Pitch.—Aside from the diameter the element on which the friction losses depend almost entirely is the pitch. The pitch of a propeller is the distance it advances in the revolution when it is turning just fast enough to produce zero thrust. It is like the pitch of a bolt thread, that is the distance the nut moves along it when given one complete turn. Aeroplane propellers secured directly to the crank shaft of the motor must of necessity have a smaller pitch, while those which are driven by intermediate gearing or sprocket chains may have a large pitch if desired. The motor must run at a high speed in order to develop its power without excessive weight, and if a propeller of large pitch is secured directly to the shaft, it would offer so much resistance to turning that the motor could not get up the speed.

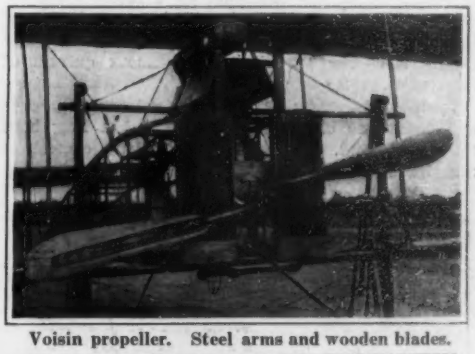
A common speed for such motors is 1,200 revolutions per minute. If the aeroplane makes a speed of 40 miles an hour, the pitch of the direct connected

(Continued on page 486.)

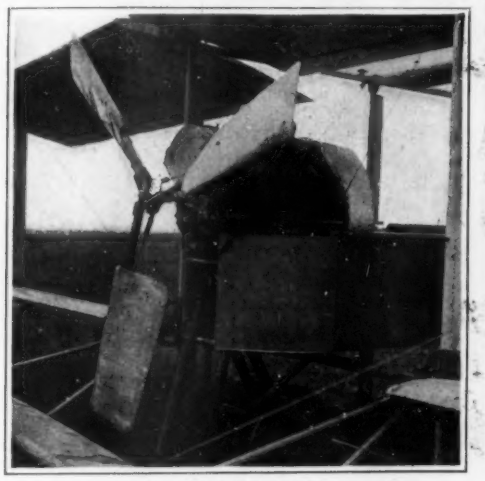


A group of propellers experimented with by Maxim.

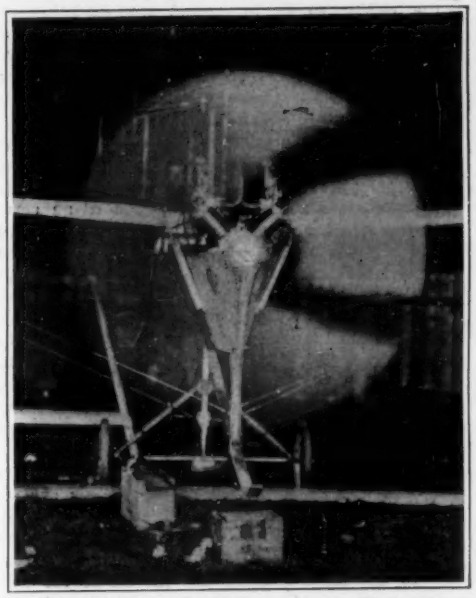
A heap of propellers abandoned by Sir Hiram Maxim.



Voisin propeller. Steel arms and wooden blades.

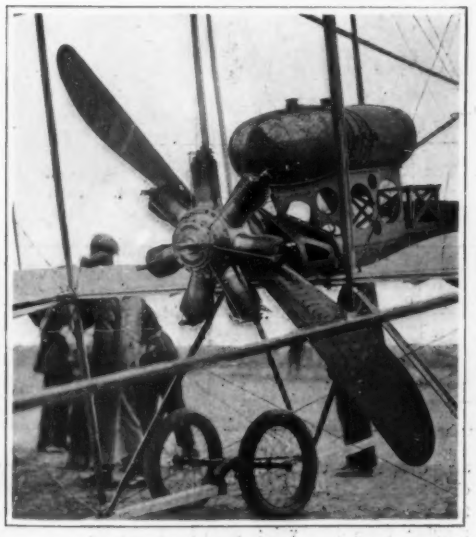


Breguet's three-bladed feathering propeller.

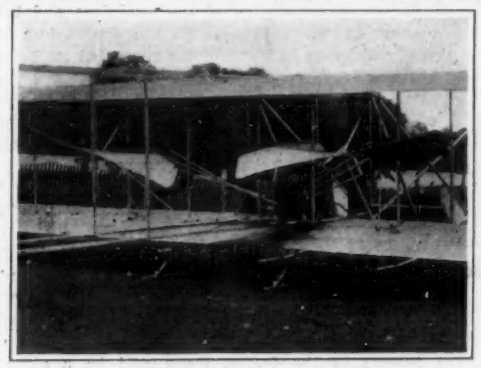


Fourteen hundred revolutions a minute. The black segments are shadows cast on the rapidly revolving propeller.

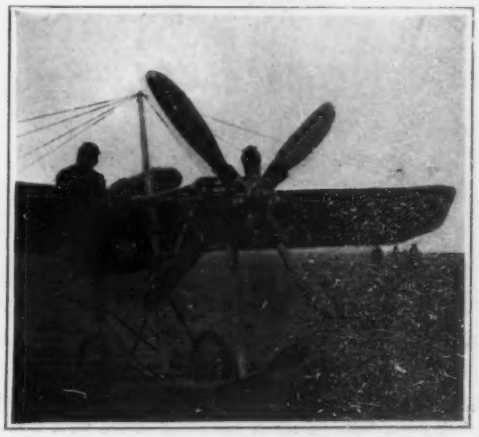
An R. E. P. motor directly coupled to a four-bladed R. E. P. propeller. Four-bladed propellers are almost obsolete now.



A Gnome motor directly coupled to Chauviere propeller.



The double propellers of the Wright biplane.



Four-bladed propeller on Paul de Lesseps machine.

TYPES OF AIR PROPELLERS

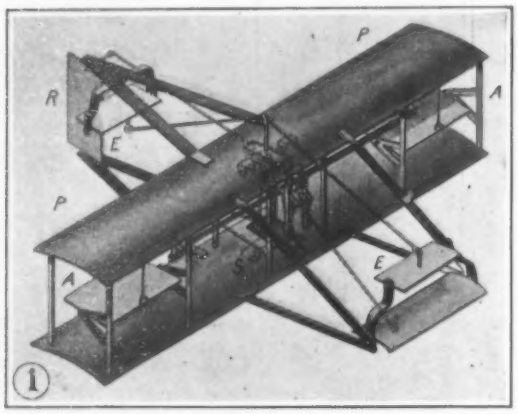
Automatic Stability of Aeroplanes

Comments on Some American Patents

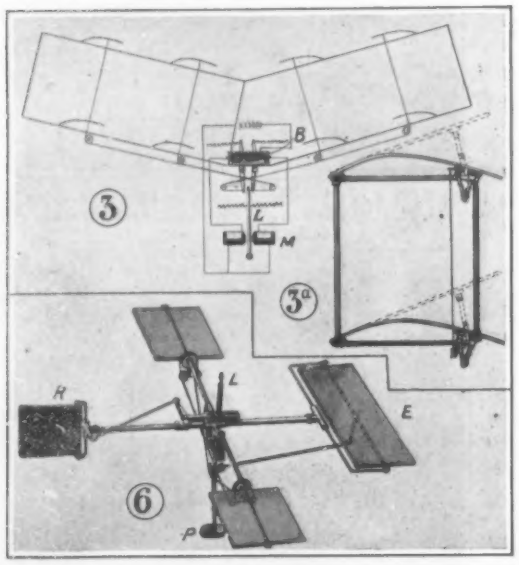
By Grover Cleveland Loening, Author of "Monoplanes and Biplanes"

AS FLYING becomes more general, the treacherous and shifty character of the air-ocean is more and more fully appreciated. The vast swirls and turmoils of the air are felt distinctly by all aviators, and the manner in which aeroplanes are wafted about on unseen billows and through invisible cross-currents is now familiar to many. One has only to watch for a few moments an aeroplane and its driver in full flight, silhouetted against the blue of the sky, to observe the ceaseless motions of the aviator closely following the equally continuous quivers of his fragile craft.

To fly on a gusty day does indeed tax the nerve and endurance of many men, and it has long been recognized that, although the voluntary control of aeroplanes is well-nigh perfected, yet the disturbing air forces are at times so sudden and so powerful that the aviator is taken unawares—often with disastrous consequences.



1. The Pressey automatic control.



3. The J. D. Pursell patent stabilizing device. 6. Automatic controlling system patented by P. R. Torbrand.

A great majority hold, therefore, that before flying can become as popular as motoring some practical form of apparatus that will hold the aeroplane in equilibrium automatically must not only be devised, but be applied successfully.

The application of some methods has already taken place, and the actual operation of other methods that have been devised will doubtlessly come within the year, so that it is appropriate and important to discuss the more noteworthy schemes and some of their particular features as exemplified in the ever-growing list of patents on "automatic stability."

There are numerous methods of attaining this highly desirable end of automatic stability, the most promising ones being:

1. The employment of the inertia of a pendulum or other mass, to move or cause other agencies to move planes or rudders, for correction, as soon as the aeroplane tilts from its normal position of flight. This method is more generally suggested than any other.

2. The employment of a gyroscopic apparatus which is designed either to hold the machine in perfect equilibrium itself, or else to "precess," and in doing so, move controlling apparatus to correct any tilt.

3. The use of auxiliary planes or light vanes, that travel in the air stream and upon a sudden inclination of the aeroplane, by their continual drifting in about the same line, cause the movement of rudders for the correction of the equilibrium.

4. The construction of the aeroplane of such materials and in such a manner that it possesses of itself an inherent elasticity, which causes it to be suspended in its element like a carriage on its springs. The Bréguet and Paulhan biplanes are notable types of this kind.

5. A rigid structure of such a form that it possesses a kind of automatic stability. The old Voisin, Pischof, Etrich, Warchalowsky and Dunne are types of this kind. There may be also included in this class all those types employing the dihedral principle either laterally or longitudinally.

6. The use of the movement of a compass needle to set apparatus in motion that will move the rudder so as to correct any deviation in direction; and the use of the movement of a barometer needle or other apparatus affected by the pressure of the air to control the rudders for altitude.

I.

The manner in which a pendulum device is relied upon to give automatic control is best shown by reference to Figs. 12, 13 and 14. Fig. 12 represents a longitudinal section of an aeroplane, showing a pendulum control *P* for fore and aft balance and an elevator rudder *E*. The direction of flight is indicated by the arrow, and in this same diagram the aeroplane is assumed to be in normal horizontal flight.

Fig. 13 shows the same apparatus immediately after a sudden gust has tilted the front of the machine up. The pendulum *P*, due to its inertia, has retained its vertical position P^1, but in doing so has pulled on the rod *ad*, causing the front elevator to assume the position E^1, and to receive the pressure of the wind on its upper face. This causes a downward force on the rudder surface which brings the machine back to the horizontal. Fig. 14 represents the effect of a sudden downward plunge of the head of the machine.

In the same manner, the inertia of the pendulum is used to move side controls, when a sudden transverse tilt occurs.

Of course the nature of the pendulum and the manner in which it controls the equilibrium is vastly different in many of the suggested methods, but the fundamental principle is everywhere the same, the pendulum itself consisting variously of an extra weight, the weight of the car, the weight of the aviator, swinging on a movable seat, or the movement of a mercury bath.

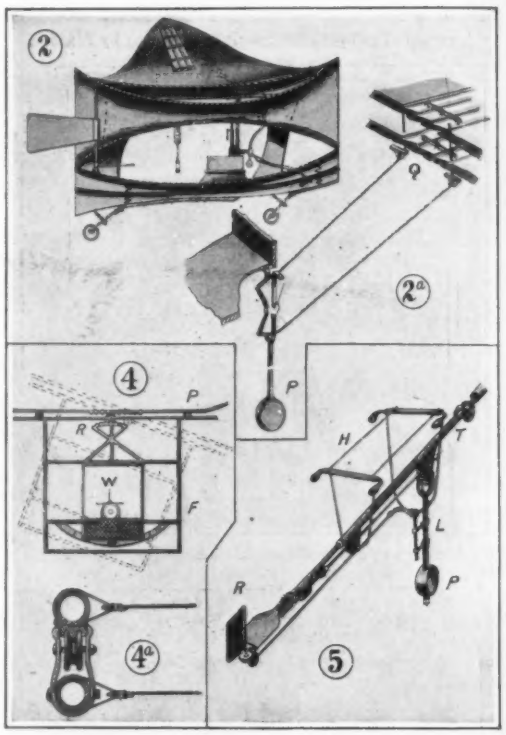
There are four distinct objections to employing any kind of a pendulum device for automatic stability:

(*a*) The first and most important objection is that, if the pendulum is at all heavy, it will tend when the machine is tilted, to accentuate greatly the tipping. Thus, in Fig. 13, due to the fact that the weight P^1 has traveled through an angle *O* with respect to the frame, there will be a strong downward pull in the direction *BA*. This will certainly accentuate the downward force at the rear, due to the vertically downward component *BC*. If the weight is heavy enough and the inclination great enough this is likely to completely unbalance the machine.

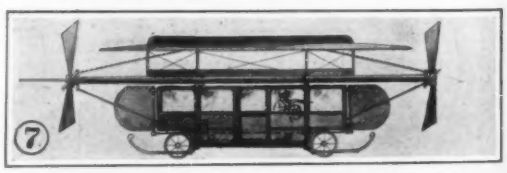
(*b*) Another effect upon a pendulum mechanism that makes it distinctly undesirable is that if there is a sudden lurch of the entire machine either forward or backward, or to either side, unaccompanied by any tilting, then the inertia of the pendulum will cause it to swing away from the side to which the machine lurches, thus moving the rudders and actually disturbing the equilibrium of the machine by either making it rise, plunge or tilt over to one side. Due to "holes in the air," sudden side gusts and even variable propeller thrusts, such sudden lurches are of frequent occurrence, and unless some means of "deadening" the pendulum is provided the equilibrium would be very unstable.

(*c*) The action of centrifugal force on making a turn will cause the pendulum to assume a position parallel to the struts of the machine or any other normally vertical parts, and it will not fly out to the outside as commonly supposed. Its action in turning, therefore, is *nil*, and to make the turn positive it would be necessary to install a separate control. This arrangement assumes a proper "banking" of the machine.

(*d*) After any displacement of the pendulum itself from its normal position due to a sudden movement or lurch of the aeroplane, the pendulum will at once tend to swing back to the normal. If the period of this swing should just happen to coincide with the frequency of any vibration or sway in the machine or with any wave pulsations of the air stream, then the swinging would continue and be amplified, eventually destroying the equilibrium of the machine. Synchronism of this sort is not at all unlikely to happen, for air waves are known to possess pulsations at regular time intervals; and in addition, propellers have often been found to give continuously and rhythmically varying thrusts, causing a slow swaying vibration in the aeroplane, quite distinct from the vibration of the motor.



2. The C. I. Lake apparatus. 4. The pivoted plane device patented by F. H. Wales. 5. The James Means patented pendulum system of automatic control.



7. A typical example of an early patented flying machine.

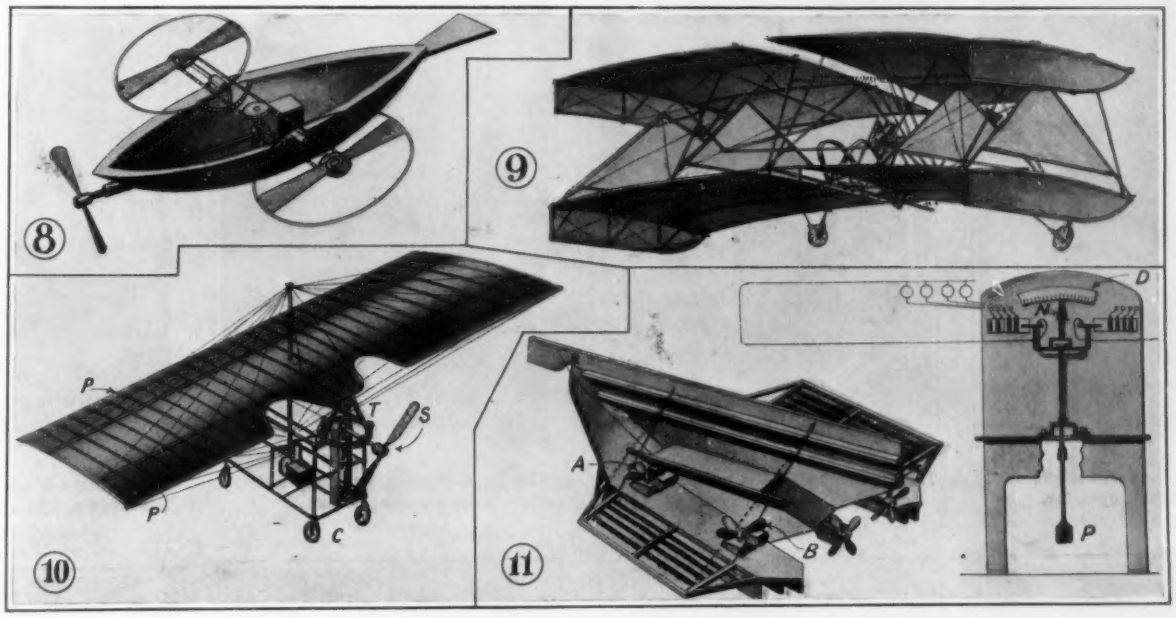
It appears, therefore, that the use of a pendulum for preserving the stability of an aeroplane is limited in its action to the condition of comparatively steady horizontal flight, and is hardly feasible in very gusty weather.

One of the earliest devices of this sort (Fig. 11) was patented by E. P. Johnston on June 5th, 1888 (U. S. Patent No. 383,889). The flying machine described is of the helicopter type, in that it is provided with four lifting screws, two of which, *A* and *B*, are shown. Any inclination of the ship either transversely or longitudinally sets a pendulum in motion, which, by means of an electric contact, governs the operation of the motive power to the propellers, so that the lift on the depressed side is increased. In addition, it is interesting to note that the patent covers the shifting of the pendulum *P*, causing a

movement of a needle *N* on a dial *D*, thus indicating to the operator the state of equilibrium of the machine.

A similar electrical control of the power supplied to lifting propellers by a pendulum, was patented in England by I. A. Colquhoun on July 29th, 1907. Sir Hiram Maxim, on April 28th, 1897, patented, in England, a pendulum device actuated by the tilting of the machine, and thus controlling the power of the engines which drive the propellers so that the machine is automatically righted.

Sylvanus S. Morrison, on October 11th, 1910, patented a device (see Fig. 10), in which the plane is pivoted to the chassis (U. S. patent No. 972,395). The chassis *C*, due to its inertia, is supposed to stay in a normal position. The tilting of the plane *P* down on any side, by means of a suitable system of levers, shafts and gears, causes the entire motor and ordinary vertical propeller system *S* to be turned around on a horizontal turntable *T* so that the thrust of the propeller and the air thrown back by it, is directed against the lowered side, thus, due to the increased draught of air, causing it to lift up.



8. An early helicopter patent. 9. An auxiliary plane system for automatic balance. 10. Pivoted plane and propeller system patented by S. S. Morrison. 11. The E. P. Johnston device for automatic stability.

On March 27th, 1906, the I. C. Hansen-Ellehammer device was patented in England. It consists merely of the system shown in Figs. 12, 13 and 14, in which a simple weight is connected by a rod to an elevation rudder, and upon the tilting of the machine up or down the inertia of the weight causes the rudder to be moved for correction.

The employment of the movement of a mercury bath instead of a weight was patented by I. D. Pursell on October 22nd, 1907 (U. S. patent No. 869,019). The mercury is contained in a barrel *B* (see Fig. 3), and when the aeroplane tilts the mercury runs to the lowered end of the barrel, thus closing a circuit and operating an electromagnet *M*, which moves a lever *L*, causing the rudders or side warping control to be set for correction of the equilibrium.

The C. I. Lake patent of April 13th, 1909 (U. S. patent No. 918,336), covers essentially a fluid jet propelled apparatus (see Fig. 2) equipped with a pendulum *P* (Fig. 2a) caused to swing by the tilting of the machine, and by thus opening certain passages and changing the fluid movement, the apparatus is brought back to an even keel.

F. H. Wales, on August 2nd, 1910, patented a system for automatic stability (U. S. patent No. 965,969). The car or other heavy movable weight *W* (see Fig. 4) is pivoted to the frame *F*, and upon the tilting of the machine to any side the car, remaining normal, causes the entire plane *P* to be shifted bodily over to the depressed side by means of a toothed segment and rack *R*. The lift on the depressed side is thus increased.

On December 14th, 1909, the pioneer James Means patented a pendulum device that has many advantages because all the movements of the pendulum *P* (Fig. 5) and rudders *R* are easily in control of the aviator through a handle bar *H*, which is part of the pendulum lever and moves with it, thus preventing eccentric motions of the pendulum. In addition, positive voluntary movement of the rudders is possible. If the aeroplane plunges head down, the pendulum *P* swings forward (with respect to the frame), and by means of a gear and rack it turns the rear elevation rudder for ascent. If there is a sudden tilt down to one side the pendulum turns a tube *T*, fitted with bevel gearing, in such a manner that the side ailerons are moved inversely for correction of the tilt.

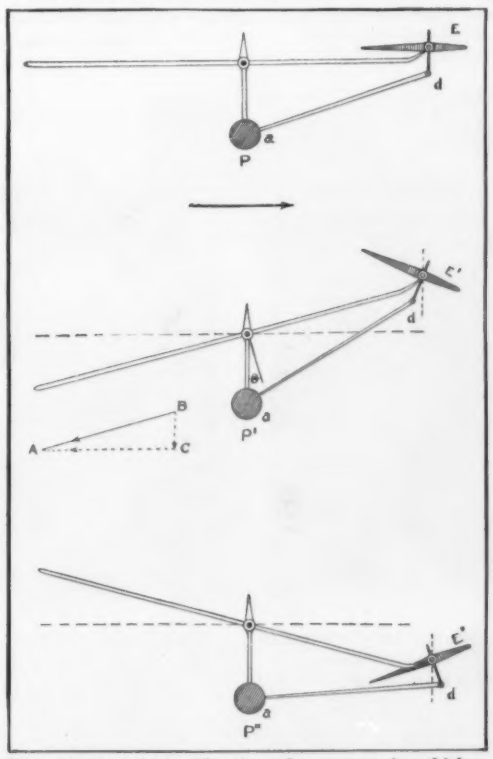
The P. R. Torbrand automatic control, patented on September 20th, 1910 (U. S. patent No. 970,974), is similar in many respects to the Means device. The pendulum *P* (Fig 6) controls the lateral and longitudinal equilibrium by movement of ailerons and rudders. A lever *L*, when moved forward and back, gives voluntary control of the elevation rudder *E* and controls the rear direction rudder *R* by side-to-side motion. There is no voluntary control of the lateral equilibrium, however, in this device, the pendulum alone being relied upon to keep the machine on an even keel transversely.

The well-known automatic control of the Wrights, patented both here and abroad, relies upon the movement of a pendulum mechanism caused by the lateral tilting of the aeroplane, which actuates a valve controlling the admission of compressed air to a cylinder, thus moving a piston and by suitable connections operating the warping of the planes and the rudder.

The Pressey automatic control (see Fig. 1) is about the simplest and most effective yet devised. In this system very little weight is added, since the pendulum weight *S* consists of the aviator seated in a swinging seat. Any sudden tilt of the machine causes him to swing in such manner with reference to the planes *PP* that the usual rudder or aileron operation at once takes place. In addition provision is made for "locking" the seat, thus enabling voluntary control of ascent or descent. *AA* are the ailerons, *EE* the elevation rudders and *R* the direction rudder.

II.

The precession action of the gyroscope offers an excellent solution to the problem of automatic equilibrium, but its action is so complicated that if its operation is not thoroughly understood there is likely to be great confusion in the preservation of the equilibrium. When any disturbance occurs, there is little doubt that a gyroscope solidly fixed to an aeroplane will cause great internal stress in the framework supporting it, and will only slightly affect the equilibrium, while it is certain that turning in any direction would be practically impossible if the gyroscope is strong enough.



Figs. 12, 13, and 14.—Showing the manner in which a pendulum preserves stability.

But if a light gyroscopic apparatus is installed, capable only of operation of the controls by its motion of precession, there is great possibility of an absolutely automatic stability. The Marmonnier and Regnard gyroscopes are devices of this sort. Up to the present, however, such devices have been found very delicate and difficult to handle, and the refinement required in their construction is great and expensive, while in any very turbulent condition of the air the action becomes so complicated that the apparatus merely jerks the rudders in every conceivable direction.

A very simple and effective means of using gyroscopic force, however, is that described in the patent of A. M. Herring. The aeroplane is equipped with two propellers rotating in opposite directions as on the Wright machine. The propeller shafts are mounted on ball and socket joints in such fashion that they can swing in a horizontal plane without affecting the drive from the motor shafts. The propeller shafts are prevented from swinging in vertical planes. When the aeroplane in flight tilts up or down, longitudinally, the propeller shafts, due to gyroscopic action, will either swing toward each other or away from each other. This movement is communicated to the elevation rudder by suitable means and causes it to right the machine.

III.

The employment of auxiliary planes or vanes that are designed to fly out in the air stream under all conditions of equilibrium of the aeroplane is a very simple method of attaining automatic stability, and one that promises much, as soon as the actual nature of the stream flow about an aeroplane is fully determined.

Capt. Etévé recently installed a device of this kind on his French Wright machine. A light hinged vane was permitted to flap freely in the air stream at the rear of the aeroplane, and was connected to the elevation rudder at the front by a lever system. Whenever the aeroplane tilted longitudinally the vane caused the rudder to move in such a manner that the machine was righted.

The Wright automatic stability patent makes use of a vane of this kind for longitudinal equilibrium, the movement of the vane actuating a valve controlling the compressed air supply to a cylinder, the piston of which operates the elevation rudder.

IV.

Elasticity of structure of the planes, as on the Paulhan and Bréguet, gives a certain degree of stability. A sudden downward gust on one side, for example, due to the great flexibility and "give" of the plane, will increase the angle of incidence on that side, thus momentarily increasing the lift and counteracting the depressing effect of the gust.

On the Bréguet the rear cruciform tail is mounted and held by light springs. A sudden upward gust on the tail will thus cause it to give way a little and be turned in such a manner that the increase of air pressure on the upper horizontal face will force it down, counteracting the upward gust. This is an admirable provision, and gives a remarkable degree of stability.

V.

The "box kite" structure of the old Voisin type and the consequent hold it had on the air is well known, as is also the upturned wing ends of the Pischoff, Etrich and Warchalowsky aeroplanes and the manner in which they tend to automatically hold the machine on an even keel. The Dunne principle of a V-shaped

(Continued on page 488.)

Some Famous American Aviators and Designers

Men Who Are Making Flying Machine History

Charles K. Hamilton, America's most daring biplane operator.

Thomas Scott Baldwin, an old airship captain now an aviator.

Charles A. Willard, first pilot of the Aeronautical Society.

"Bud" Mars, the Curtiss aviator, who has made many cross-country flights.

Wilbur Wright, the elder of the two brothers who built the first practical aeroplane.

J. Armstrong Drexel, American millionaire Blériot pilot, noted for his altitude flights.

J. A. D. McCurdy, the Canadian Curtiss pilot, who flew from Key West almost to Havana.

Walter Brookins and his "Baby" Wright. He invented the spiral dive.

Glenn H. Curtiss, winner of the Scientific American trophy. First to rise from water in a biplane.

Earle L. Ovington, the first American to own and fly a 70-horse-power Blériot monoplane.

Frank Coffyn, the Wright pilot and instructor. He has made noteworthy cross-country flights.

Clifford B. Harmon, our leading amateur aviator, who flew across Long Island Sound.

Some Famous European Aviators and Designers

Men Who Are Making Flying Machine History

Alfred Leblanc, France's chief representative in the Bennett Cup race.

Claude Grahame-White, England's leading aviator. He won the last Bennett Cup race.

Legagneux, the all-round French aviator, who has made records with both monoplanes and biplanes.

Vedrines, the Morane monoplane pilot who won a $4,000 prize by his 400-mile flight from Paris to Pau in 6 h. 55 m.

Weyman, the American, who last summer all but won the $20,000 prize captured this year by Renaux.

Louis Blériot, France's premier monoplane inventor; first to cross the English Channel, July 25th, 1909.

Pierre Prier, the Frenchman who flew from London to Paris without a stop at over 60 miles per hour.

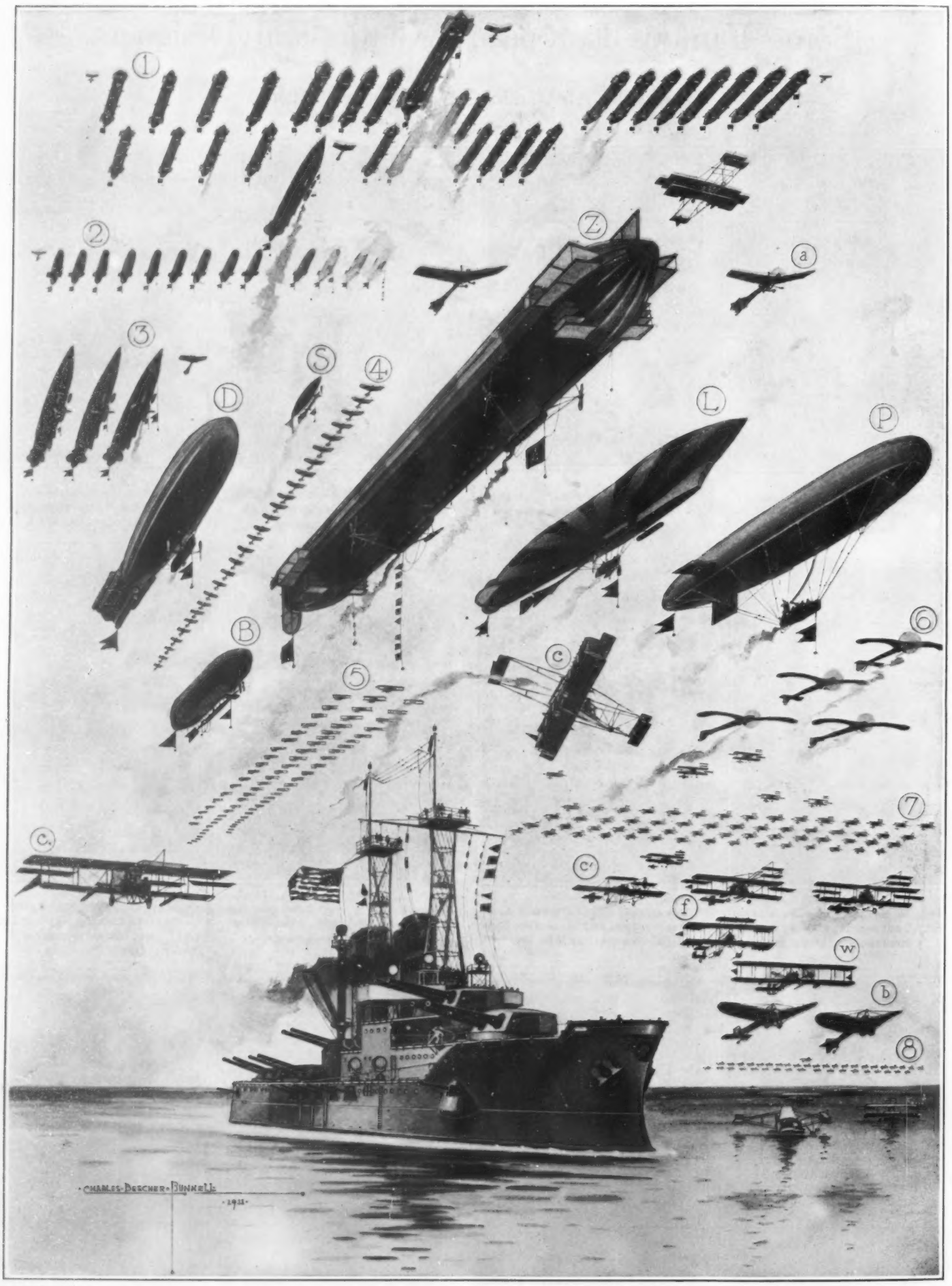
Morane, the former Blériot pilot, who has invented an exceedingly fast and efficient monoplane.

Eugéne Rénaux, who won the $20,000 Michelin prize. He flew from Paris to the top of the Puy de Dome mountain with a passenger.

Louis Bréguet, leading French inventor and aviator. First to carry live load equaling weight of machine (11 passengers).

Robert Esnault-Pelterie, inventor and designer of R.E.P. monoplane. He is one of the best aviation engineers of the day.

Pierre Marie Bournique, French R.E.P. monoplane pilot, who made excellent long-distance speed records last year.



Explanation of the above reference figures, etc.: 1. Squadron of 29 Zeppelins (Dreadnoughts). 2. Squadron of 13 Parsevals in command of 1 Lebaudy (cruiser). 3. Squadron of 3 Lebaudys (cruisers). 4. Squadron of 27 Blériot monoplanes. 5. Squadron of 74 Wright biplanes. 6. Squadron of 4 vanadium racers, Scientific American type. 7. Squadron of 69 "big Curtiss biplanes." 8. Squadron of 46 Curtiss hydro-aeroplanes. Z. Zeppelin dirigible (Dreadnought class). D. Deutsch dirigible (cruiser class). L. Lebaudy dirigible (cruiser class). P. Parseval (cruiser). B. Baldwin (scout). S. Santos Dumont (scout). c. Commander of aero scouts. c'. Curtiss monoplane. c Scout aero. f. Farman biplane scout. w. Big Wright (scout). b. (2 types) Blériot. a. Antoinette (1 to each flagship and 2 to the commanding officer's ship).

Some mistaken enthusiasts believe that the money put into battleships would be better spent in creating fleets of airships. Both will be required—battleships for the warfare of the seas; aeroplanes and dirigibles for the battles of the air.

A TEN-MILLION-DOLLAR AERIAL FLEET FOR THE COST OF ONE DREADNOUGHT

A Ten Million Dollar Aerial Navy for One Dreadnought

Naval Aircraft Will Never Supersede Cruisers and Battleships

IN the development of a new art, particularly when it makes such a phenomenal advance as has marked the recent progress of the airship and aeroplane, the public is liable, in its enthusiasm, to ascribe to the new invention capabilities which are far beyond its present powers. Particularly in regard to the art of flying is this tendency made manifest, and nowhere so much as in respect of the usefulness of airships and aeroplanes in warfare.

Not infrequently the argument has been made, both from the platform and in the press, that the vast sum of money which is expended in creating a single dreadnought might better be devoted to creating a whole fleet of dirigibles and aeroplanes. That the money cost of one dreadnought would be sufficient to build a fleet of aerial craft cannot be disputed; but to argue that such a fleet would have the same practical usefulness as the one mighty ship is an altogether different proposition.

The consensus of opinion among naval and military men at the present time indicates that they believe the immediate sphere of usefulness of air craft will lie in the work of scouting, for which they will prove to be simply invaluable.

The aerial scout will change the whole system of strategy, and this for the reason that it will render impossible that secrecy upon which the whole theory of strategy is founded. We showed many months ago that the commanders of two opposing forces will henceforth be somewhat in the position of two chess players, each of whom has a fairly certain knowledge of what the next move of his opponent will be.

There is probably no country to which the introduction of aeronautics into the domain of naval warfare is fraught with such serious possibilities as it is to Great Britain, whose very existence as a first-class power depends in the last analysis upon the maintenance of her naval supremacy. Hence we attach particular importance to a recent discussion of the subject by leading officials of the British navy, in which it was agreed that the advent of the aerial scout would have but little effect upon the design of future battleships. It was agreed that airship must fight with airship, aeroplane with aeroplane; and that just as the security of the island was preserved by maintaining a navy of overwhelming force, so Great Britain will be driven to the necessity of building fleets of dirigibles and aeroplanes which will show a similar preponderance to any probable combination of the aerial fleets of other powers.

At the same time, it is certainly interesting to study the accompanying fanciful sketch which our artist has drawn, showing a modern dreadnought stripped for the fight, and above it, a composite fleet of dirigibles and aeroplanes, whose cost would approximately equal that of the single warship. He finds that for the ten million dollars expended on the ship, it would be possible to construct 30 Zeppelins, 14 Parsevals, 5 Lebaudys, 1 Deutsch, and 2 small scout airships, making a total of 52 dirigibles, at a cost of $8,760,000. The remaining $1,240,000 would suffice for the construction of 118 Curtiss biplanes, 75 Wright biplanes, 29 Blériot monoplanes, 8 Antoinettes, 4 high-speed all metal machines of the type described in the SCIENTIFIC AMERICAN of October 22nd, 1910, and one Farman biplane. Thus, according to the estimate of our artist, for the cost of a single dreadnought, it would be possible to put in the air no less than 287 air craft.

For identification (in the picture): The "dreadnoughts" carry square flags, fore and aft, the "cruisers" a "swallow-tail" two-pointed flag, and the "scouts" a single point flag. The "dreadnought" marked *Z* in the drawing is directly over the "North Dakota," so that the relative sizes can be noted. The marks *D*, *L* and *P* indicate three "cruisers" on a line with the "Zeppelin." The aeros marked *c*, *f*, *w* and *b* are on a line with the "Dakota." The 52 dirigibles depicted are provided with life-boat cars, and the 235 aeroplanes are also hydroplanes. Dirigibles are rated something as follows: "Dreadnoughts," 300 horse-power, 450 feet by 42 feet; "cruisers," 135 horse-power, 200 feet by 36 feet; "scouts," 30 horse-power, 90 feet by 19 feet.

Let it be understood that no such darkening of the air by a multitude of aerial craft, crowded as they are shown in the picture, would ever be possible. The disturbance of the atmosphere caused by the wash of the various machines would, of course, throw the craft out of equilibrium and render them unmanageable. If ever the flying machines of the future maneuver in large bodies, it will be necessary to scatter them over a wide expanse or arrange them in successive planes at varying altitudes.

Aviation Prizes at Home and Abroad

More Than a Million Dollars to Win

MORE than a million dollars in prizes has been offered for special flights and for improvements in aeroplanes during the balance of the year 1911.

As will be seen from the list printed below, America is as far behind Europe in the giving of prizes as she is in the flying of machines. The great progress which has been made by the French in aviation has been chiefly due to the encouragement received from wealthy men, manufacturers, and newspapers, in the shape of large prizes for performing feats in the air. Perhaps no one in the entire world has done more for the development of aeronautics in this way than Senator Henri Deutsch de la Meurthe, whose name still figures in the list of prize givers.

Probably the first cash aviation prize offered in America was that offered through the SCIENTIFIC AMERICAN by Mr. Thaddeus Hyatt July 25th, 1860. This prize of $1,000 was never competed for or won. Again, in 1907, the SCIENTIFIC AMERICAN itself put up the SCIENTIFIC AMERICAN Trophy, which was won three years in succession by Glenn H. Curtiss, now its permanent possessor. Last year Mr. Edwin Gould made a generous offer through the SCIENTIFIC AMERICAN of $15,000 for the machine equipped with multi-motors and multipropellers that makes the best performance in a flight of one hour. The rules of this prize appear in this issue. July 4th is the date fixed for the tests of the machines entered.

Last summer, after the $10,000 prize offered by the New York *World* for a flight from Albany to New York had been won by Glenn H. Curtiss, this newspaper put up another prize of $30,000 for the first aeroplane flight from New York to St. Louis in a period of 100 hours. The New York *Times* also offered a prize of $25,000 for a flight from Chicago to New York. Neither of these prizes was competed for, and both have been withdrawn, although if any sportsman aviator comes forward and wishes to attempt the former flight, the prize will no doubt be found awaiting him. The New York *American*, last October, offered a prize of $50,000 for a flight from San Francisco to New York, the time allowed being thirty days. This prize offer is open until October 11, 1911.

For the perfecting of the aeroplane motor, the Automobile Club of America has offered a prize of $1,000 for the motor which makes the best performance in a three-hour continuous test. The date of closing of the entries for this contest is July 1st. Full particulars regarding it can be obtained from the secretary of the Automobile Club. This contest has been open for a year past, but as the rules stipulate that three motors must be entered for competition in order that the prize may be won, and as the requisite number of contestants has never been obtained, there has been no competition thus far. In a contest for a similar prize limited to English motors and offered by Patrick Y. Alexander for a 24-hour continuous run, a four-cylinder aeroplane motor, known as the "Green," proved to be the best, and Mr. Alexander has since put up another prize for such a test.

LIST OF PRIZES IN AMERICA, ENGLAND AND THE CONTINENT.

PRIZES IN AMERICA.

Automobile Club of America's motor reliability prize	$1,000
Gould-Scientific American Prize (see p. 487)	15,000
World prize for flight from New York to St. Louis (tentative)	30,000
Hearst prize for flight across the continent	50,000

PRIZES IN ENGLAND.

Manville prize (British aviators only) for long distance flights on nine specified dates	2,500
Michelin prize for longest flight above an aerodrome during 1911	2,500
Michelin prize for 125-mile trip across country, British aviators only	2,000
Mortimer Singer prizes ($2,500 each) for cross-country flights by army and navy pilots	5,000
Patrick Y. Alexander's engine reliability prize	5,000
Gordon-Bennett Cup race prize (July 1st)	5,000
London *Daily Mail* 1,000-mile race around Great Britain, starting July 22nd at Brooklands	50,000

PRIZES ON THE CONTINENT.

Fastest flight from Nice to the Island of Corsica	$2,000
L'Auto prize, Paris to Bordeaux	2,000
Rene Quinton prize for longest distance volplane (glide)	2,000
Aero Club of France prize for longest circular flight	2,000
National Aviation prize, Paris to Orleans	4,000
Tour of the South of France	4,000
French Ministry of Works prize for French constructors	4,000
Dufayel prize, Bagatelle to Lettarre	4,000
Aero Club of Bearn prize, Paris to Pau (won by Vedrines on Morane monoplane)	4,000
Michelin prize for longest distance above an aerodrome in France	4,000
Quentin Bauchart prize for passenger carrying	10,000
Pommery Frères prize for longest straight flight (French aviators only)	10,000
Deutsch prize for circuit around Paris	12,000
Let Petit Parisien prize, race from Paris to Madrid, starting May 21st	20,000
Automobile Club of France's Grand Prix	20,000
L'Aéro's prize for flight across the Mediterranean	20,000
German Circuit, finishing at Berlin	40,000
Aix-les-Bains meeting	40,000
Circuit in Saxony, starting at Chemnitz May 20th	47,500
Over-sea Circuit, Calais-Dover-Folkestone-Boulogne	60,000
Petit Journal prize, Paris to Rome, starting last of May	80,000
The *Standard*, *Le Journal*, and other papers, Circuit Paris-Brussels-London-Paris, starting June 18th	85,000
Russian aerial tour, starting from St. Petersburg	100,000
French Government competition for military aeroplanes	240,000
Prizes at meets and circuits in Germany, Italy, Russia and Belgium	150,000

Rapid Increase of Life

AS illustrating the enormous powers of rapid increase exhibited by both the animal and vegetable kingdoms, which have insured the continuance of the various types of existing life from the earliest geological ages in unbroken succession, while being an important factor in the production of new forms by adaptation, the following instances may be cited:

A common weed, the *Sisymbrium Sophia*, produces three-quarters of a million seeds, and these, if they all grew and multiplied, would in three years cover the whole land surface of the globe. Darwin calculated that the slowest breeding of all animals, the elephant, would in 750 years, from a single pair, produce 19,000,000 individuals. Rabbits would, from a single pair, produce 1,000,000 individuals in four or five years.

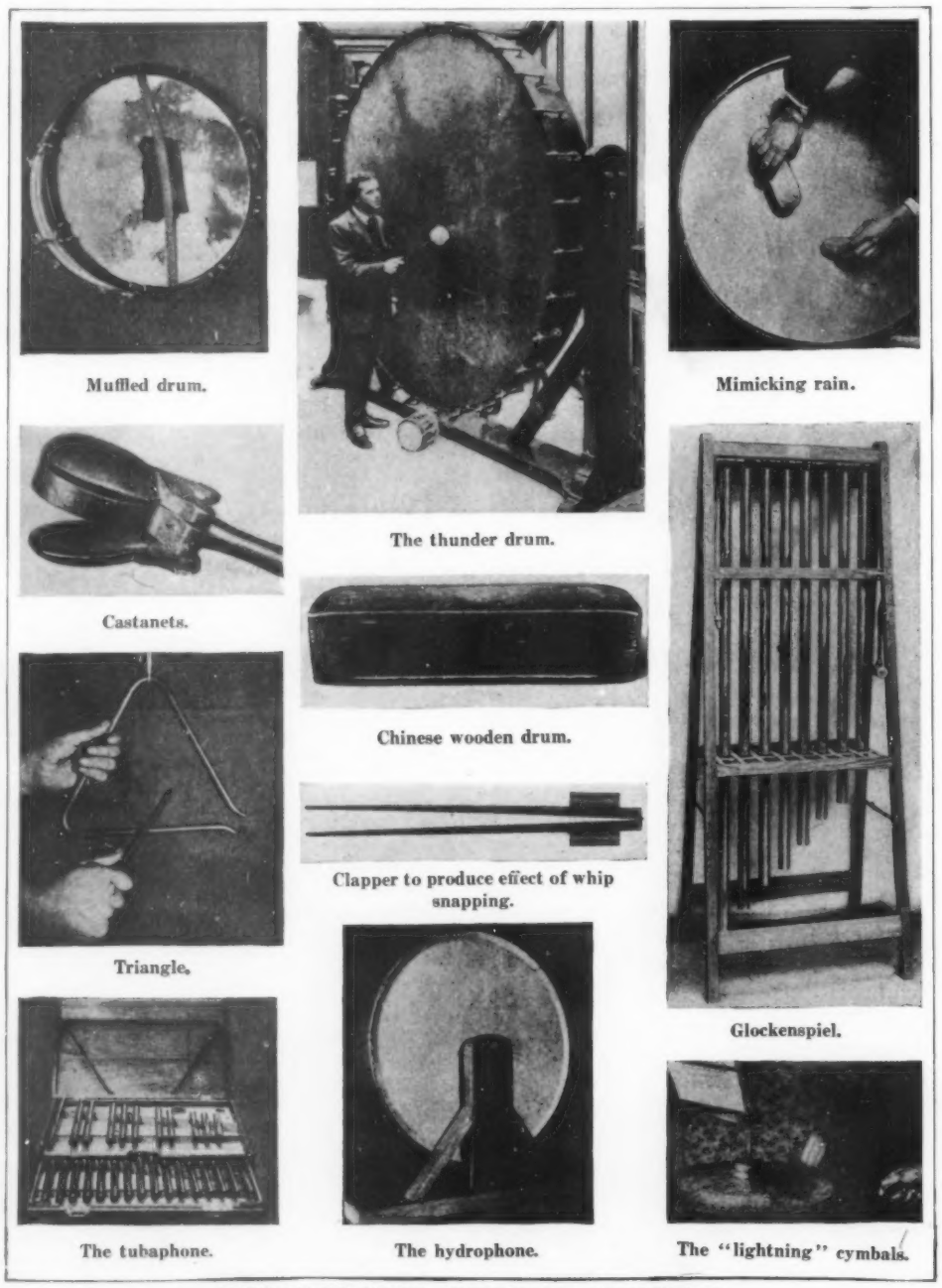
Abstracts from Current Periodicals

Phases of Science as Other Editors See Them

Instruments Used by Richard Strauss

IN the attempt to obtain realistic effects in orchestration, Richard Strauss is a past master. His "Symphonia Domestica" is a pretty accurate phonetic reproduction of household troubles and joys. In his "Death and Transcription," the battling of a man with death on a sick-bed was musically portrayed with almost frightful reality. In "Salome" and "Electra" all the resources of the modern orchestra were drawn upon to call forth dramatic effects so crassly real that many a hearer was more horrified than pleased. Our German contemporary, *Ueber Land und Meer*, publishes the accompanying illustration of some of the more remarkable instruments which Strauss uses in obtaining his effects. Some of them are hardly musical instruments, but merely noise producers, and a few are by no means new.

Muffled drums have always been used in funeral marches, and Strauss, too, employs them whenever some lugubrious opportunity offers. Every melodrama in which a thunder storm figures includes among its properties a huge drum. Strauss's drum is a good deal larger and flatter than the ordinary bass drum which produces Jovian thunder and booming artillery. The effect of rushing water and hissing steam is produced by the simple expedient of rubbing a drum head with brushes. The musical portrayal of lighting necessarily calls for an instrument of incisive sound. Hence, in connection with the thunder drum, a cymbal is used, which is struck with a felt-covered stick. The cymbal and the thunder drum are companion instruments. Castanets and triangles are familiar instruments, and Strauss employs them chiefly for heightening the rhythmic effect of dances. The trampling of horses and the dancing of negroes is very realistically mimicked by means of a Chinese wooden drum, which is beaten with tubular sticks. Similar in their character are the "glockenspiel" and the "tubaphone," both of which are not particularly new, but rarely used. The plashing of rain is imitated by means of a hydrophone, a drum which is filled with small stones, mounted upon bearings and rotated. The cracking of whips is reproduced by means of wooden clappers which are similar to those which small boys use.



SOME OF STRAUSS'S ORCHESTRAL INSTRUMENTS

The Plague and Its Spread

IN a paper appearing in the *Journal of the Royal Society of Arts*, J. Cantlie publishes a discussion of peculiar interest on the mode of occurrence and spread of the plague. The phenomena presented are somewhat complex, and far from fully explained. There are certain aspects in the situation that are somewhat disquieting—the disease exhibits some properties of a very insidious character. We quote the writer in his own words:

"The prevalence of plague in the world in epidemic form since 1894 to the present moment—a period of sixteen years—is a matter of supreme interest and importance to the people of every nation. The question naturally arises at the moment: Has the virulence of the malady spent itself, and may we look forward to an abatement of the pandemic, and a hope that it may speedily disappear altogether? The history of previous epidemics does not engender a hopeful answer that it may do so; all previous outbreaks indicate the long continuance of plague among every community in which it has gained a serious hold. It is not a question of a prevalence for a few weeks or months or even years, but a continuance for several decades in any populous district where it has found a footing. In London, when plague last visited us in the seventeenth century, although the mortality was high for only a comparatively short time, local outbreaks occurred for a long period, and sporadic cases until the beginning of the eighteenth century. Judging even by the behavior of the present epidemic, plague has lasted now for seventeen years in Southern China, and for fifteen years in India. Speedy disappearance of the disease from regions severely attacked is, therefore, not to be calculated upon—in fact, its long continuance is rather to be expected. It is this characteristic of plague which causes the disease to be dread as it is, for it is the only malady which prevails in epidemic form for a number of years in any given country.

"The endemic home of plague among human beings is a matter of doubt. So far it is believed that plague is always present in the Indian provinces of Kumaon and Ghurwal, on the southern slope of the Himalayas; but whether this is the only home of the disease, or whether there is, in addition, another in Mongolia, and yet another in East Africa, is not known. It may be that in no part of the earth is plague endemic among men, but that the disease is kept alive only among certain animals, and now and again in the history of the world does it attack man. There is much to be said for this opinion. Certain animals, especially of the rodent class, seem to be liable to plague in an epidemic form, but whether it is endemic among these animals is not known. That plague is endemic among rats is not known. That it occurs in epidemic form is abundantly proved, but whether it is the rat that keeps the bacillus alive from one century to another seems uncertain, and it is unlikely from the very fact that it is so virulent among them at times. There is some evidence that the marmot may be the true harborer of the plague infection.

"Plague manifests its presence in man more frequently in the form of bubonic plague than in any other form. In Biblical times even the bubo or emerod, as it is spoken of in Leviticus and I. Samuel, was the prominent evidence of the presence of the disease. Surgically a bubo means an enlargement or swelling occurring in a gland anywhere in the body, due to some irritation or inflammation in its neighborhood. In plague there are three situations in which buboes may be felt. Most frequently it is the groin glands that enlarge, but the glands of the armpit and the neck may be the seat of the swelling. The bubo, however, is not the first indication of the disease; in fact, it is rather a late manifestation, for it may not be until the third day or later that it shows. Like other infections, plague begins with feverishness, headache, backache, a feeling of chilliness, or even a rigor; there is a loss of appetite, a foul tongue, usually black in center, and congested throat; vomiting is frequent, and diarrhœa or constipation obtains; mental aberration is an early manifestation, and may continue throughout the illness. As a rule, if the patient lives over the fifth day, recovery may be expected, and the third and fifth days of the illness are the most dangerous. If the eighth day is survived, the hope of recovery is good, the chief danger then being failure of the heart through sudden movement or getting out of bed, walking across the floor, and leaning over the veranda or staircase railing.

"The pneumonic form of plague we have heard about especially in the epidemic which is now raging in North China. It is an acute form of the disease, which attacks the lungs so extensively that death comes in two or three days. It is highly infectious, runs rapidly through a household, and occurs with such rapidity and virulence that there is no time even to bury the dead. The plague in North China recalls the accounts given of plague in former epidemics in Europe, and the Black Death, with all its horrors, is abroad in the world. We begin to understand that

there may be stages in the development of plague epidemics, reaching from a low to a high degree of virulence, and from a meager to an extremely dangerous state of infectivity."

A curious phenomenon which has been observed is that the occurrence of the plague is apt to be preceded by a precursor, taking the form as it were of a mild form of plague, termed *pestis minor*, which is epidemic, but comparatively harmless. In fact, all appearances seem to indicate that the disease runs through a regular cycle of development stages:

(1) *Pestis minor.*
(2) Bubonic plague.
(3) Pneumonic plague.

That these are related the one to the other would seem incontestable; that each possesses a special variety or type of virulence due to peculiar characters of its bacillus, and transmitted in different ways in each type, would also seem true. That rat-flea infection plays, no doubt, a part in this scheme, but, as Dr. Hossack, of Calcutta, remarks, it is but a link in a chain of some length—a chain, we would add, in which other animals and man play a part.

"This part of the question is of special interest, because it may be of importance in estimating the approach of plague in any country, and it would be well to keep this point in view in our hospitals in this country, and to watch if cases of buboes are becoming more prevalent. In this way we might hope to gage the proximity of true plague in its virulent forms.

"The facts seem to be that there are three stages in this disease. *Pestis minor*, carried only by insects from diseased animals, is always local—a household outbreak, in fact—in which a pseudo-plague bacillus is found in man. Bubonic plague is carried from man to man by insects. Pneumonic plague passes from man to man without the intervention of insects. The virulence of each variety gathers in intensity. Time is required for one type to change to another more virulent, each variety propagates its like until, by prolonged cultivation in the blood and tissues of a particular animal, or in man, it changes its type and becomes specific for that animal. As the tuberculosis of animals may in time and in suitable soil change in type, so that it develops in man, and then is directly transmitted from man to man, so is plague in time altered in type, so that it no longer requires an animal host, but in times of epidemic passes from man to man, and becomes wholly a disease of human beings.

"The stages would appear thus to be:

"(1) Disease in animals.

"(2) *Pestis minor*, conveyed by infected insects.

"(3) Bubonic plague, sporadic cases, carried from animals to man by insects.

"(4) Epidemic bubonic plague, carried from man to man by insects.

"(5) Pneumonic plague, passing from man to man directly, or conveyed by insects.

"It would seem, therefore, that severe as bubonic plague has been in China and India, yet a worse form may develop, for pneumonic plague is the culmination of this chain of virulence, and China and India may have been but the fostering beds in the development of the bacillus which has now attained its highest development in Manchuria, and may pass over the world, as it has frequently done before, in the form of the Black Death. At present, science offers no means of preventing such a calamity, except it be a preventive such as Haffkine's prophylactic serum, which would seem to have done good service in India, where bubonic plague has chiefly prevailed.

"Infection by rat fleas is sufficient to explain sporadic cases of bubonic plague, and plague endemicity, but it is wholly inadequate to explain an epidemic of bubonic plague which can only occur by infection from man to man, possibly by insect carriers.

"An important point to be observed in the epidemiology of plague is that animals, chiefly rodents, the rat in many places, the marmot in North China, the squirrel in the United States, etc., may suffer from plague for years without infecting mankind, except in a sporadic way. Then suddenly an outbreak occurs which prevails in an epidemic form. In Northern China this has been proved to be the case, and in any country where rodents are infected, the same sequence may be anticipated. Rats have been found to be infected in Britain, in Glasgow, in the Port of London, and in Suffolk; also in Germany, in Hamburg, and elsewhere; squirrels are known to be infected in the United States, more especially on the Pacific slope. In these countries small outbreaks of a sporadic nature have occurred from time to time. The outlook, reasoning from experience, is not hopeful, for the peoples of these countries are dwelling in places in which rodents are infected, and at any moment the disease may appear in an epidemic form in man."

High-frequency Generator for Wireless Telegraphy

IT is announced in the daily press that Dr. Goldschmidt has recently succeeded in sending wireless messages from Berlin to the Southwestern frontier of Germany, using his new high-frequency alternator to generate the electric oscillations. The production of undamped waves by means of high-frequency alternators has been the aim of numbers of inventors, as it is hoped that by producing a suitable generator it may be possible to avoid the defects of working that are associated with the usual arc and spark methods. The subject, with especial reference to Dr. Goldschmidt's method, is discussed in *Nature* by A. J. Makower. This author writes:

"A number of alternators have been built, but owing to various reasons none of them has as yet come into extended use. Their design on the usual lines is very difficult, as even if the rotating parts are made to revolve at the highest speeds permissible from mechanical considerations, the number of poles required to produce the high frequencies necessary for wireless telegraphy is so great as to leave very little room for the windings, and the consequent cramping of the windings and great leakage between the closely spaced poles give rise to considerable drop of voltage when load is put on the machine.

"Most of the machines that have been constructed hitherto have been of the inductor type, consisting of fixed windings paced under the influence of rapidly rotating armatures of iron containing a large number of projections or teeth, but the Goldschmidt machine is built on a quite different principle.

"It is a phenomenon well known to those who have to work with single-phase alternators that when load is put on such machines the armature reaction causes double-frequency currents to flow in the field winding, and that these double-frequency currents cause triple-frequency currents to flow in the armature winding, and so on. This may be explained by the consideration that a stationary alternating flux can be regarded as being composed of two equal and constant fluxes rotating with equal speeds in opposite directions, the speed of the two fluxes being such that one complete revolution is made by them in the time of one period of the alternating flux.

"Applying this to the case of an alternator with stationary alternating-current winding and rotating field system, it will be seen that if the rotating field produces alternating currents of a frequency f in the stator, the component rotating fields produced by the stator currents will rotate at the same speed as the field system, one in the same direction as the field winding, and therefore having no inductive effect on it, and the other in the opposite direction, and therefore inducing a current of a frequency $2f$ in it. A continuation of this process would cause currents of frequencies $2f$, $4f$, $6f$, etc., to appear in the field winding, and currents of frequencies $3f$, $5f$, $7f$, etc., to appear in the stator winding. The production of the higher frequency currents in ordinary alternators is limited by the fact that the amplitudes of the series of harmonics decrease rapidly, owing to the great impedance opposed to their flow in the windings, but the triple-frequency harmonic superposed on the fundamental is often sufficiently marked to cause undesirable distortion of the wave-shape of the electromotive force of the machine.

"Dr. Goldschmidt has constructed a machine in which the effect referred to is utilized to produce currents of very high frequencies, although the fundamental frequency of the machine is comparatively low. In order to prevent the damping out of the higher harmonics, he connects in parallel with the stator windings a series of capacity-inductance shunts tuned to resonance with the odd multiples of the fundamental frequency of the machine, and in parallel with the field winding a series of such shunts tuned to resonance with the even multiples of the fundamental frequency. Owing to the presence of these shunts the high-frequency currents are able to attain considerable magnitudes, and the electrical energy is reflected backwards and forwards between the stator and motor of the machine a great number of times, the frequency of the oscillations being increased at each reflection until a frequency corresponding to the free period of the radiating circuit is reached.

"In Dr. Goldschmidt's machine, oscillations of 120,000 cycles a second are produced, and the rated output is 12 kilowatts.

"Practical experience of working will be necessary before it is possible to say to what extent machines of this type are likely to replace the present oscillation generators, but it seems not unlikely that difficulties will arise in keeping the frequency of the oscillations constant enough to enable clear signals to be received.

Why an Engine Moves

WHY does an engine move? The following is the simple explanation of *Railway and Locomotive Engineering:*

"Let us confine our attention to one side of an ordinary locomotive, with 20x24-inch cylinders and 56-inch driving wheels, and a boiler pressure of 200 pounds. The master mechanics' rule for the mean effective pressure in the cylinders is 85 per cent of the boiler pressure, and in this case it amounts to 170 pounds.

"This engine has a piston area of 314.16 square inches and 170 pounds on each square inch imparts a total pressure to the piston of 53,40[illegible].2 pounds, but for the sake of facilitating the calculation, let us say 53,400 pounds M. E. P. With piston at the back end of the cylinder and crank pin on back quarter, or just above it, the pull of the piston on rod, crosshead and main rod reaches the pin. The wheel is a lever with fulcrum on the rail. This fulcrum changes from moment to moment as the wheel rolls along, and the point of contact between wheel and rail is called the instantaneous fulcrum, as the length of the lever or the operating part of the wheel above it changes momentarily. It is easy to see that if the crank pin is ever so little above the center line of the axle the pull of the main rod will turn the wheel and the engine will move forward. The effective pull, as we have seen, was 53,400 pounds, and this is applied to the wheel lever of maximum length when the crank pin is on the top quarter, for this is 40 inches above the rail.

"The force of 53,400 pounds is therefore applied to the crank pin, pulling it forward, but at the same time exactly this pressure is applied to the back cylinder cover, and the cylinders bolted to the frame carries this same force back to the axle box and tends to push box, axle, and indeed the whole engine backward. The center of the axle is, however, only 28 inches above the rail. We have therefore the same force, viz., 53,400 pounds, applied to two levers of different lengths, one 40 inches long and the other 28; that is in the proportion of 10 to 7. The moment of the force at the crank pin, about the instantaneous fulcrum at the rail, is $53,400 \times 40 = 2,136,000$, and that at the axle is $53,400 \times 28 = 1,495,200$. The difference between these two moments is 640,800, in favor of the crank pin, and the engine moves forward.

"On the back stroke the pressure on the piston and front cylinder cover is 53,400 pounds, and the moment of the force at the crank pin when on the lower quarter or 16 inches above the rail, is 854,400. The moment of the force at the axle-center about the fulcrum on the rail, is 1,495,200. The thrusts on the pin tend to drive the pin, wheel and engine backward, while the pressure on the front cylinder-cover, frame and axle, tends to drive the engine ahead. The difference between these two moments is 640,800; the same as in the previous case, and the engine continues to move ahead.

"On the back stroke the steam practically pulls the cylinder over the piston a distance of 2 feet, but the half circumference of the wheel is 7.33 feet, which is the distance the engine moves ahead. On the forward stroke the piston is pushed through the cylinder 2 feet, while the engine moves ahead 7.33 feet.

"To picture the push of the piston as it acts on the crank pin when below the center line of the axle, let us suppose we have an ordinary wheelbarrow with wheel at the left-hand side of the observer. Suppose that the two legs of the barrow have small wheels so that the whole can easily be pulled along without anyone touching the handles. Now tie a string to the vertical spoke on the lower half of the wheel. This is the one standing between the hub and the ground. If this string leading forward from the barrow be pulled, one would almost expect that the wheel would move in the direction of the hands of a clock, and that the wheelbarrow would move backward, and one would almost expect the spoke with the string attached would swing to the left.

"As a matter of fact, neither wheel nor spoke move in this way, and anyone who cares to prove it can easily do so with a toy cart or other small vehicle. If there is sufficient weight on the wheelbarrow to prevent slipping, a pull straight ahead on the string attached near the rim to the vertical spoke will actually produce a motion of the wheel in a counter-clockwise direction, and the pull on the string becomes stronger in consequence, and the wheelbarrow will roll forward toward the man who is pulling on the string. This action is exactly opposite what occurs on the engine. Similar action to what takes place on an engine would be secured if the man got on the wheelbarrow and applied force to the vertical spoke below the center line of the wheel."

The Story of the Cadillac

This story not only describes the many superior features of the Cadillac car but it gives much information which the automobile buyer wants to know and which will be of advantage to him no matter what car he may favor

IN THE FIELD OF MOTOR CARS, the Cadillac stands pre-eminent as representing the most advanced development along truly practical lines.

As it stands to-day it embodies principles and methods in construction which have proven their correctness in forty thousand Cadillacs which have preceded it.

The Cadillac has the advantage of being manufactured in the plant whose experience, organization, equipment, facilities and methods are without parallel in the industry.

To a Cadillac was accorded the distinction:—"The first practical motor car." That this distinction was merited, it is but necessary to direct attention to the fact that notwithstanding those cars (some 2,000 of them) were made nine years ago, not one, so far as we are aware, has been discarded as worn out and unfit for further service. If there be any other car of which the same statement can truthfully be made, we do not know of it.

The Cadillac "Thirty" upon its introduction, in 1908, marked the beginning of a new era in motor car manufacture. It set aside all pre-existing standards of value. It established the new criterion by which motor values should thenceforth be judged.

NOONTIME AT THE MAIN PLANT

This Cadillac represented the solution of the problem of producing the highest type of motor car, to be sold at a price which theretofore would purchase only mediocrity. It stayed the industry until it could adjust itself to the newly inaugurated condition. The Cadillac had many followers in its wake but its lead has never been lessened and after three years its position remains as clearly defined as at its inception. It was the first car to be offered at a so-called "moderate price" which was accepted as a serious competitor to cars selling at more than double its price. It still stands alone in that position. No better evidence can be offered of the correctness of this assertion than that the Cadillac finds a very material share of its purchasers among those discriminating motorists whose ideals had been realized only in cars for which they paid from $3,000 to $5,000 or possibly more.

The success of the Cadillac has been pronounced remarkable. Yet, it is not remarkable—excepting by comparison. Its success is nothing more than what could be expected for a motor car such as it is. Its success is due to its deserving merit—to the thorough satisfaction and constancy of the service which it has rendered to its users.

The Cadillac embodies no untried principles in its make-up for the purchaser to try out at his own expense and annoyance. The fitness of every essential part and its ability to perform its functions has been proven in trying service.

Cadillac cars are manufactured almost in their entirety in the great Cadillac plants. These plants include foundries, both iron and brass. They include pattern shops, sheet metal shops, gear cutting shops and machine shops. They include body building, finishing, enameling and trimming departments. In these plants are manufactured the motors, the transmissions, the radiators, the hoods and the fenders. There are also plants for the manufacture of even small parts—capscrews, bolts, nuts, etc.

The equipment of the Cadillac plant in the matter of fine machinery, fine tools, jigs and fixtures is not equalled in any other motor car factory in the world—a statement which will be verified by those who have had the opportunity of a personal inspection. This equipment includes more than half a thousand special automatic labor saving machines, some of which are capable of turning out from two to ten times the volume of work produced by the ordinary methods which obtain in most factories—and doing it far better. The equipment includes approximately 100,000 tools, jigs, fixtures and dies of which nearly 20,000 were designed and made by us especially for the manufacture of Cadillac cars. The expense for tool maintenance alone has exceeded $100,000 in a single year.

The unrivaled reputation enjoyed by the Cadillac product, the constant and enduring service rendered, the economy of operation and maintenance are not matters of mere chance. They are the logical outcome of Cadillac principles and Cadillac methods.

Of the many distinctive features characteristic of the Cadillac, that of thorough standardization has ever been one of the most pronounced. The advantages of standardization are manifold; a motor car cannot be what it ought to be without it. The disadvantages of its absence can scarcely be calculated.

Standardization means that every individual part is exactly like every other part of its kind without even the one-thousandth of an inch variation where that degree of accuracy is essential. It means the absolute interchangeability of parts. It means that when for any reason it becomes necessary to replace a part that the part may be ordered from the factory and that it will fit without the slightest alteration.

In the Cadillac there are 167 parts and 237 operations which are not permitted to deviate to exceed one one-thousand of an inch,—about one-third to one-half the thickness of a hair—from the prescribed limits of measurement. There are some parts in which the limit of variation permissible is cut down to the half of one one-thousandth.

So accurately is every piece made that thousands of pieces of a kind with thousands of pieces of other kinds are sent to the various assemblying departments where they are all "put together" with the use of only wrenches and screwdrivers—not so much as the finest file or emery cloth being necessary.

Standardization means correct alignment and that the parts will work in perfect harmony. It precludes the possibility of ill fitting joints and bearings. Standardization decreases the great power absorbent—friction. It limits wear. Standardization reduces "automobile troubles" to a minimum. It brings operating and maintenance cost down to the lowest notch.

Standardization produces a quiet and smooth running car. In this respect, the Cadillac is not equalled outside of cars selling at two to three times its price—and very few of those.

The system of inspection maintained in the Cadillac plant is so exacting that it practically precludes the possibility of an imperfect part being incorporated in the car so far as can be detected by the most accurate measuring instruments known to engineering science. From the time the raw materials reach the warehouse until they leave the plant they are under the careful scrutiny of a corps of experts trained in accordance with the high standards of the Cadillac organization. This inspection extends to the smallest pieces, even nuts, bolts and screws.

While standardization has reduced wear at friction points to the lowest possible limit, the car is provided wherever possible with adjustments for taking up any wear.

The Cadillac is a car manufactured practically under one roof instead of merely an assembly of motor transmission, frame, axles, etc., obtained indiscriminately here, there and everywhere that they may be had at the lowest price, regardless of quality. This is a feature which no buyer can afford to overlook.

The Cadillac Company is prepared to replace any part of any car it ever built. No Cadillac user was ever obliged to discard his car because of inability to obtain some needed part. No Cadillac user was ever obliged to pay an exorbitant price to have such part made to special order because the maker had gone out of the business, had discontinued making parts for old models or had to depend upon some outside parts maker to supply them.

The Cadillac "Thirty" has repeatedly demonstrated its speed capabilities at from five to fifty miles an hour on high gear and its superior hill climbing abilities are recognized the world over.

It is a sturdy and dependable car. Its motor is the most powerful of its dimensions ever designed. Its strong and substantial construction, the perfect fit and perfect alignment of its working parts enables the maximum of the motor's power to be delivered to the ground—in marked contrast with flimsily constructed cars in which material is skimped to save cost and in which the twisting and binding strains consume much of the power.

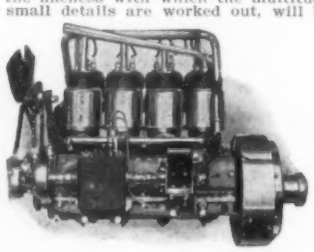
The Cadillac has demonstrated its right to the distinction of being the most carefully built car ever produced. It has demonstrated its right to the distinction of being the most economical multiple cylinder car, both in operation and maintenance. It has demonstrated its right to the distinction of being the most reliable and the most serviceable car. It has demonstrated its right to the distinction of being the greatest automobile value ever offered.

Motor.

The Cadillac motor is entirely different from any other—and to its differences is attributable its superiority. The use of this type of motor in every four cylinder Cadillac ever made covering a period of nearly seven years, has failed to develop a single deficiency. On the contrary, as the years go by and their numbers increase, the more pronounced is the conviction that for all the essentials that go to make a motor what it ought to be, the Cadillac motor occupies a position unique and alone.

It is constructed upon the "built-up" and "individual part" principle, a principle conducive to efficiency, power, simplicity, smoothness of action, long life and economy. Notwithstanding the advanced manufacturing methods employed in the Cadillac plant, this type of motor is the most expensive to produce. While that construction may necessitate a higher selling price for the complete car than would be required were we to build a motor in the ordinary way, the extra cost is compensated for many times over by the greatly increased service and satisfaction it will render and the lessened expense for operation and maintenance.

It is of the four cylinder, four cycle type, 4½" cylinder bore, by 4½" piston stroke. By the generally accepted method of calculation, it is rated at 32.4 horsepower. This method, however which considers only the bore of the cylinders regardless of the general design of the motor, the accuracy of its workmanship or the fineness with which the multitude of small details are worked out, will be



CADILLAC "THIRTY" MOTOR

readily realized as totally inadequate for determining the power of a Cadillac motor, especially when compared with motors of ordinary construction.

It is produced by that division of the Cadillac plant which during the past decade has produced a greater number of high grade gasoline motors and gears than any other plant in the world.

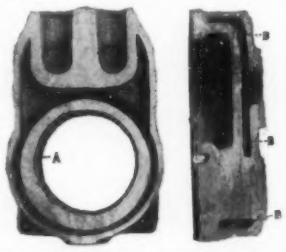
Each cylinder is cast by itself as are also the cylinder heads which contain the valve chambers. The heads are attached to the cylinders by right and left threaded nipples. The water jackets which surround the cylinders are of spun copper and are clamped into position in such manner, and the surfaces between which they are clamped are so accurately finished, that we have never heard of a single case of leakage.

The proper circulation of water around the cylinders is of the utmost importance to the efficiency of a motor. By casting each cylinder by itself it enables us to make the walls of uniform thickness and by applying the copper jackets it leaves uniform space for water circulation, resulting in even cooling of the entire cylinder with the resulting advantages.

CADILLAC CYLINDER AND COPPER WATER JACKET

Note the even thickness of cylinder wall and uniform space for water circulation

We show here some of the advantages of our method of construction as against the ordinary practice of casting cylinders, valve chambers and water jackets together. In the illustration below is shown a cylinder with valve chamber and water jacket cast integral. This illustration is made from a photograph taken of a cylinder and water jacket cut in two horizontally. Note the varying thickness of the cylinder wall "A." With this condition existing it will be readily understood that it is impossible for the circulating water to cool the cylinder uniformly. The result is that the contraction and expansion of the metal will be so varying that the bore of the cylinder will not retain perfect roundness. In consequence it will bind the piston at certain points of its travel and fit so loosely at others that the lubrication is imperfect, that wear is uneven and disastrous and that there is a great waste of fuel with a corresponding loss of power.



ORDINARY CASTING OF CYLINDER WITH WATER JACKETS INTEGRAL

Note varying thickness of cylinder walls and uneven water circulating space. Also webs which interfere with circulation.

In the smaller figure will be seen the webs "B" which are sometimes formed when the two parts of the core used in casting are not held firmly together. This web is sure to obstruct the circulation of the water, causing overheating of the cylinder with its undesirable consequences, and is something that is impossible to detect without destroying the cylinder.

We do not wish to be understood as saying that it is impossible to make such casting correctly, but it is a fact that many are not made correctly.

When cylinders, valve chambers, and water jackets are made separately, as in the Cadillac, an injury to any one part calls for the replacement of only that particular part at but a moderate cost, while in the case of cylinder, valve chamber and water jacket cast together, and particularly when cast in pairs or all in one, an injury to any one part necessitates taking down the motor, replacing the entire combination casting, and reassembling.

Our cylinders, pistons, and piston rings are cast in our own foundry from special grades of metal made after our own formulas, the result of years of experience, experimenting and testing in our own laboratories. This metal possesses unusual strength and toughness, and a critical inspection reveals a marked absence of the spongy portions and blow holes characteristic of many castings. It possesses the further and most essential quality of resisting to the greatest possible degree the influence of heat, consequently it is not so susceptible to contraction and expansion as are other castings. The superior qualities of Cadillac castings are so widely recognized and appreciated that for years we have made cylinder, piston and piston ring castings for a number of other automobile manufacturers, making the highest priced cars in America.

How CADILLAC Cylinders are Tested for Accuracy

The accompanying illustration shows the method of gauging Cadillac cylinders. Every cylinder after being ground must stand this final test. Two gauges are provided. One of them is marked "4,500 Go," meaning that it is exactly four and one-half inches in diameter. The cylinder must be large enough to permit this gauge to enter. The other gauge is marked "4,502 Not Go," meaning that its diameter is just two one-thousandths of an inch larger than four and a half inches, but the cylinder must not be so large that it will permit this gauge to enter. If a cylinder is too small to permit the "Go" gauge to enter, the inside is ground until it is the correct size. If the cylinder is large enough to permit the "Not Go" gauge to enter, it is discarded.

When you realize that one gauge is less than a hair's breadth larger in diameter than the other; when you realize

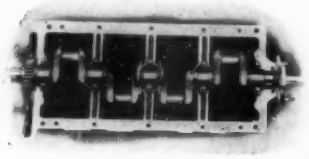
THE STORY OF THE CADILLAC---*Continued*

that one will enter the cylinder and the other will not; when you realize that there are 237 dimensions in the Cadillac car which are not permitted to vary more than the one one-thousandth part of an inch, which is about half the thickness of the average human hair, then can you form some conception of why Cadillacs are what they are, and why they render the constant service that they do.

Cadillac pistons are gauged to similar accuracy, a snap gauge however being used which gauges the outside diameter of the piston.

The result is that neither cylinders nor pistons can possibly vary in diameter even a hair's breadth. Consequently, ANY piston will fit in ANY cylinder. They do not have to be "paired." If it ever becomes necessary to replace a piston, all the owner has to do is replace the piston. He is not necessarily obliged to replace the cylinder also, or possibly a pair of cylinders or the whole four as might be the case where they are cast in pairs or all together.

In finishing the cylinders and pistons, we do not stop at simply machining. Every one of them is ground to a polished surface resulting in practically perfect compression and consequently maximum power. The piston rings are finished with the same precision and are also made from our own special formula differing from that of which the cylinders and pistons are cast. This metal possesses exceptional spring qualities not easily affected by the heat of the motor. Therefore, they retain their efficiency long after the ordinary ring would be rendered practically worthless.



CADILLAC OIL PAN AND CRANK SHAFT
Note the five large substantial bearings
Also Showing Oil Wells and Distributing Troughs

The crank shaft is substantially supported by five large bearings insuring that firmness and rigidity essential to a smooth running, vibrationless and durable motor.

These bearings are of a large surface, made of Babbitt metal with bronze backing. Incidentally, we had occasion to examine the bearings of a car which had traveled 46 000 miles, yet the wear proved not to exceed the one one-thousandth of an inch. Each bearing is made in halves and, should occasion ever require, they may be removed, replaced or adjusted through the hand holes in the crank case without even disturbing the crank shaft.

The crank shaft is offset; that is instead of being placed directly in line with the middle of the cylinders it is set slightly to one side. Therefore, the force of the explosion is expended to greater advantage than is possible in motors where the crank shaft is in line with the middle of the cylinders when the explosion occurs.

This feature has been embodied in Cadillac cars for years; in fact, the offset crank shaft has been used in Cadillac since their beginning, in 1902.

Upon the accuracy of the cams and cam shaft and the accurate fit of the cam shaft in its bearings depends the correct operation and timing of the valves and the correct timing of the valves is one of the greatest essentials in the development of maximum power. To insure these requisites we grind both the cams and the shaft, the latter within a half-thousandth of an inch limit. These parts are special heat treated high carbon steel. The cam shaft is also supported by five substantial bearings of special Cadillac bronze, which afford it the maximum degree of rigidity which is not obtainable with a lesser number of bearings.

The inlet and exhaust valves are all located on the right side of the motor and are operated by the single cam shaft. The valve lifting rods do not bear directly on the cams The lower end of each rod is provided with a hardened steel roller and consequently the possibility of wear is reduced to an absolute minimum. This is a feature which outside of the Cadillac, is found only in the highest priced cars.

The motor base or crank base is cast in two parts having four compartments. The ends and dividing walls support the five crank shaft bearings. The hand holes in the crank case provide access to all parts within. The entire motor is constructed with a view to accessibility of all parts which may require attention.

The cooling system used on the Cadillac is not equalled in any other motor car at any price. The radiator is our own design, made in our own factory. It is composed of 150 seamless copper tubes passing vertically through 135 horizontal copper plates,—copper because it radiates or throws off heat better than other metals. In the method of manufacturing we have inaugurated a wide departure from the usual practice of dipping the entire radiator in molten solder after assembling, a practice which is followed to cover poor workmanship and poor material and a practice which has a decided tendency to reduce the radiating efficiency. The Cadillac method is to confine the solder as closely as possible to the points where the tubes pass through the plates without covering the plates themselves. By this method we obtain the maximum radiating efficiency. All parts and passages with which the water comes in contact are made of either copper or brass—no iron or steel or other metal subject to rust. Before assembling, each individual tube is tested and the finished radiator is also tested by air and water pressure. The water circulation is promoted by a gear driven centrifugal pump. The air draft through the radiator is augmented by a ball bearing, belt driven rotary fan. With our radiator construction, the copper jacketed cylinders and uniform water circulating space, we have a system that comes nearest perfection of any that has ever been devised. The radiator is mounted on the chassis by our three point contact method. Therefore, it is not liable to distortion or damage resulting from the strains to which the car frame may be subjected.

The clutch is the leather faced cone type. It is of pressed steel, giving it great strength without needless weight. The ring with which the cone engages is split at eight points of its periphery and part of each section is sprung in-

ward. This causes the clutch to take hold gradually so that in starting the car there is that noticeable absence of shock and jar characteristics of most cars.

This clutch is devoid of the usual complications. It is extremely simple and requires the least attention of any motor car clutch ever designed. In the matter of efficiency, ease of operation, dependability and service, it is not even approached. It requires but a few minutes to remove it, if necessary.

The motor entire is mounted in the chassis frame by our three point suspension plan. By this method, any twisting strains to which the car may be subjected due to uneven road conditions do not materially affect the alignment of the motor and its working parts.

Ignition.

In the very essential matter of Ignition the Cadillac is equipped with two separate and complete systems, each with its individual set of spark plugs. Either system is efficient for operating the car, entirely independent of the other.

For one system we use the Bosch high tension magneto.

As an auxiliary ignition, we have adopted the new Delco Distributor System.

We use this system not merely for starting but to afford Cadillac users a dependable reserve ignition that can be used for running any distance with satisfactory results.

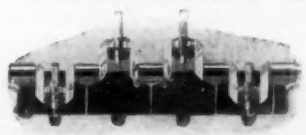
Lubrication.

In the important matter of lubrication, the Cadillac is provided with the most efficient, the most positive and the most economical system ever devised, the oil consumption averaging from 500 to 800 miles per gallon. This system in its present perfected form was originated by the Cadillac Company and the fact that it has been used on all four-cylinder Cadillacs since their beginning, in 1905, and the fact that it has successfully met every condition is the strongest possible testimony to its merit.

A quantity of oil is placed in the oil pan of the crank case. An oil reservoir is placed alongside the motor; in this reservoir is located a double acting force pump, the supply from which may be regulated to take care of the motor's requirements. By means of splashers at the end of each connecting rod which dip into the oil at each revolution of the crank, the oil is thrown completely over and upon all the inside working parts of the motor, including main bearings, cylinders, etc.

There are four compartments to the crank case, the ends and dividing walls of which support the five main bearings.

With the Cadillac system there is no possibility of the oil collecting in either end of the crank case as the sloping



SECTIONAL VIEW OF CADILLAC CRANK CASE AND CRANK SHAFT
Showing Oil Wells and Distributing Troughs

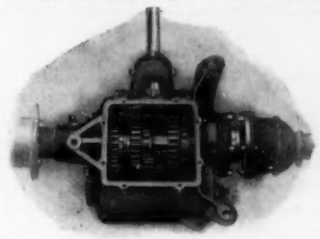
troughs on the sides distribute it from one compartment to the other, maintaining a uniform and constant level in each, regardless of road grades, up or down.

There is another prime advantage. There is not a multiplicity of feed pipes to watch that are liable to become clogged up and result in burned out bearings. On the contrary, there is but one and if the oil is shown by the sight feed to be feeding properly and the supply in the crank case adequately maintained, there is positive assurance that all bearings taken care of by this system are being perfectly lubricated.

No one thing is responsible for more "automobile troubles" in a well designed and correctly constructed car than imperfect lubrication. The Cadillac is unusually well provided with lubricating facilities throughout.

Transmission.

The Cadillac transmission is as superior to the usual transmission as the Cadillac motor is superior to other motors. It is more substantial, more positive and by operators of long experience, it has been pronounced the most easily operated of any they have ever used. It is our own design, manufactured in our own factory. It is the selective type of sliding gear. There are three speeds forward and reverse, direct on high. The gears, also the transmission shaft and clutch shaft are made of chrome nickel steel. The construction is Cadillac quality throughout. The utmost skill is exercised in cutting and finishing the gears and other parts according to the Cadillac



CADILLAC SELECTIVE TYPE SLIDING GEAR TRANSMISSION

system of limit gauges which insures hairs-breadth accuracy. These parts are then treated by a special process which gives them extreme strength, toughness and wear resisting qualities.

The gear teeth are "backed off" or beveled by machinery especially designed for the purpose. This facilitates the shifting of the gears without the crashing and grinding characteristic of some construction.

The main transmission shaft, the jack shaft and the clutch revolve on five annular ball bearings.

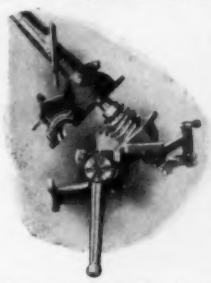
Drive.

The drive is direct by special heat treated high carbon steel shaft, fitted with two universal joints having hardened and ground bushings and pins. The joints are enclosed in spherical housings and run in oil baths. The forward joint, which is telescopic, is so constructed that it is self-centering, resulting practically in the elimination of friction and binding strains characteristic of ordinary construction. The drive shaft revolves on Timken bearings. The torsion member is "V" shaped, tubular. When the car is carrying a normal load the power is transmitted in practically a straight line from the motor to the rear axle with the result that the maximum of the generated power is delivered to the ground.

The foregoing are some more of the reasons why the Cadillac shows more power than any other car having a motor of its size.

Steering Mechanism.

Like most important features of the Cadillac, the steering mechanism is different from any other type. It is of our own patented design and manufacture, of the worm and worm gear sector type. The parts are all accurately cut and hardened, and the worm gear is fitted with two ball thrust bearings. The teeth in the middle of the sector, being the ones which are in mesh when the car is driven straight ahead, naturally perform the greatest service and are therefore most susceptible to wear. To compensate for this the center teeth are all on a slightly less pitch radius so that any wear may be taken up without affecting the upper or lower teeth of the



CADILLAC STEERING GEAR

sector; consequently they do not bind when turning corners. We know of no other car equipped with a steering device capable of adjustment to the degree which characterizes our own.

A steering gear that is not provided with proper adjustments is apt to become worn to such an extent that the resulting back lash will make steering both uncertain and unsafe.

The adjustment provison of most gears is simply for original setting at the factories so that when the parts become worn they must be replaced by new ones. In our mechanism the provision for adjustment is more adequate than will probably ever be required.

Springs.

One has but to ride in the Cadillac to fully appreciate its superb riding qualities. It carries its own good road with it. Its spring suspension is generally conceded to be the most luxurious ever installed on a motor car.

The forward suspension consists of two semi-elliptical springs, 36 inches long by two inches wide.

CADILLAC REAR SPRING SUSPENSION

The rear suspension is of the three-quarter platform type, a type which is recognized as the most conducive to comfort, but which makers of cheaply constructed cars cannot afford to use and which few have sufficient knowledge to apply correctly. Like most other features, this is one which the Cadillac Company has perfected to a marked degree.

Like all other Cadillac construction, that of the springs is given more attention than usual. The utmost care is exercised in the selection of the material, in the manufacture and in the testing of the springs themselves. All springs eyes are made with hardened steel bushings and all parts are made within close limits to prevent rattling, to minimize wear and to preserve correct alignment.

Attention is further directed to the spring perches. These are not attached rigidly to the rear axle as in ordinary practice but are of the oscillating type, moving upon the axle tube. This not only prevents undue straining, and twisting of the springs in going over obstructions or into depressions, but in connection with the previously mentioned refinements it permits the full benefits of spring efficiency to be realized.

Axles.

The rear axle is the Timken full-floating type with Timken bearings throughout. This is a type of axle which outside of the Cadillac will be found only on higher priced cars. In this axle the load of the car is carried on the housing the live axle shafts simply transmitting the power to the rear wheels. The driving pinion made of nickel carbon steel and the bevel driven gear made of special carbon steel, are both cut and finished in our own gear cutting division by Cadillac methods which insure their accuracy.

The front axle is drop forged, I beam section with drop forged yokes, steering spindles, spring perches, and tie rod ends. The front wheels are fitted with Timken bearings.

Brakes.

A thoroughly efficient and dependable brake system is one of the greatest essentials to the safety of the motorist.

The Cadillac is equipped with two pairs of powerful, double acting brakes which operate directly on the rear wheel hub drums which are 14 inches in diameter by 2½ inches wide.

It is well-known that it is a difficult matter to adjust a pair of brakes so that the tension or gripping qualities will be uniform on both. To overcome this we have compensating devices on both the service and emergency brakes which automatically take up any inequality in the tension and cause the pressure to be applied equally on both brake drums. This not only adds materially to the efficiency of the brakes, but is a large factor in preventing skidding.

Brake and Control Levers.

The Cadillac "Thirty" is equipped with the standard form of control. There are no confusing combinations on any one lever; each has its separate and distinct function. There are two hand levers at the driver's right; one applies the internal expanding hub brakes, the other is the speed change lever. There are also two foot levers; one operates the main clutch and the other applies the external contracting hub brakes. The two foot levers are adjustable to accommodate drivers with different lengths of limbs.

The throttle and spark levers are located conveniently at the steering wheel. An accelerator or foot throttle control is also provided.

Wheels.

The wheels are the best obtainable and equal to those used on the highest priced cars. They are of the artillery type made from well seasoned second-growth hickory with steel hubs. The spokes are of ample dimensions to insure great strength.

Frame.

The frame of the "Thirty" is strong and substantially braced. It is made of pressed steel, channel section, with 2½ inch drop so that the weight is carried closer to the ground yet not interfering with the clearance. Its width is 33 inches in the rear reduced to 30 inches in the front which enables the car to be turned in a 34-foot circle. All cross members are hot riveted with pneumatic hammers, a process which prevents loosening of the rivets and parts.

Finish.

No motor car is better finished than is the "Thirty," Cadillac finish is noted the world over for its excellence and durability. Inasmuch as this work is done in our own shops and not let out on contract, we are able to give it the same careful supervision and inspection which characterizes all Cadillac workmanship.

The seats are luxuriously upholstered in selected full hides of hand buffed black leather, tufted over deep coil springs and fine quality genuine curled hair. The seat cushion springs are all Royal Arch construction, a type conducive to the highest degree of comfort as it is practically impossible for the occupant to strike the base.

Styles.

The Cadillac is furnished in several types of bodies at the following prices: Touring car, Demi-tonneau and Roadster, $1,700; Fore-door touring car, $1,800; Limousine, $3,000. Prices F. O. B. Detroit including the following equipment, Bosch magneto and Delco ignition systems. Pair gas lamps and generator. Pair side oil lamps and tail lamp; horn and set of tools. Pump and repair kit for tires, 60-mile season and trip standard speedometer; robe rail; full foot rail in tonneau and half foot rail in front. Tire holders.

Adv.

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Simple Patent Law; Patent Office News; Inventions New and Interesting

The "Valveless" Gas Engine

By Hayner H. Gordon of the United States Patent Office

TO write an article, dealing almost entirely with the valves of some of the newer types of internal combustion motors, and then to give it the title of this article, may seem not only startling, but contradictory. This incongruity, however, between title and subject matter, disappears when the statement is made, that every internal-combustion engine of the four-cycle type, must have valves in order to make it run, a statement which will perhaps be better understood, when the principle of operation of the modern four-cycle gas engine is explained.

In such an engine, the piston makes two downstrokes, and two upstrokes, to complete one cycle of operations. In the first stroke down, a vacuum is produced in the cylinder, and the charge of combustible gas is drawn in. On the upstroke, this charge is compressed to about sixty pounds per square inch.

When the piston reaches the top of its stroke, the charge is ignited by some such means as an electric spark, and the piston is then driven down on its working stroke. On the next upstroke, the exhaust valve is open, and the products of combustion are exhausted. It is easily seen that some means must be provided to govern the inlet and exhaust ports at the proper time, in order that the functions of the cycle may take place in proper order and sequence. By definition a valve is any device for controlling a passage. The engine must therefore possess valves in order to be operative.

Valves may generally be divided into two classes.

In the first place, there are those which operate by lifting from a seat with which they make a gas-tight joint. The ordinary poppet-valve is the best example of this type. In the second place, there are those valves which by the sliding of one part over another bring two parts into register, and form a passage. As this sliding motion may be either rotary or reciprocatory, both rotary and reciprocatory valves belong to this second class.

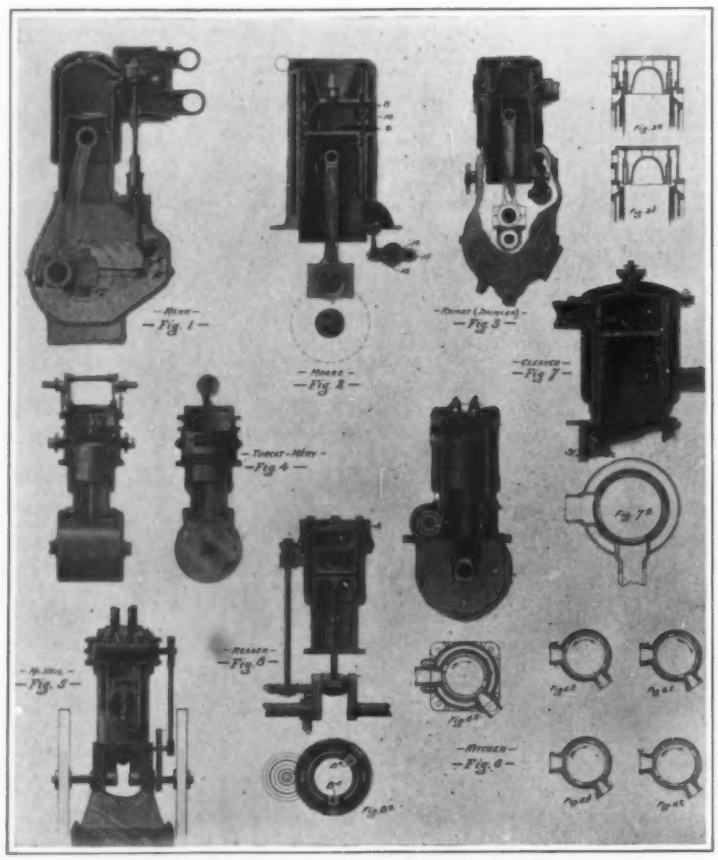
Up to the present time, it has been nearly a general practice to equip the ordinary four-cycle motor—such as is used in automobiles—with valves of the poppet type. These valves are nominally held on their seats by springs, being lifted up by cams. The last few years, however, have witnessed the adaptation of valves of the second class to the four-cycle motors, and it is this type of valve which applied to the internal combustion engine, produces the so-called "valveless gas engine."

The term "valveless" appears to have its origin in the fact that, engines with valves of the second class, do away with all the noise attendant upon the use of poppet valves with their springs and tappets. A person seeing one of these engines run for the first time would generally come to the conclusion that the engine produces the so-called "valveless gas engine.

The application of sliding and rotary valves to the gas engine is not new. In fact, the first gas engine to attain any marked degree of commercial success used slide-valves for controlling both inlet and exhaust. This was the Lenoir Engine, patented in France in 1860, and in the United States in 1861. One of the first rotary valves shown in connection with an internal combustion engine, appears in a United States Patent, granted to Burger, in 1875.

Reciprocating slide valves, as applied to the internal combustion motor, may be divided into two classes. First, those which are of the ordinary piston or slide valve type. Secondly, those which are of the sleeve type, and which either slide on the interior of the cylinders, between the cylinder walls and piston, or else surround the water jacket of the cylinder, and reciprocate on the outside. Fig. 1 shows a modern slide valve (invented by Mann), which is representative of the first class. The valve, which is of the piston type, made tight by the packing ring 10, reciprocates up and down in the valve cylinders, opening first the inlet and another part is exposed to the cold incoming charge.

Fig. 2 shows the Moore sliding-sleeve valve, located between the piston and cylinder walls. The sliding-sleeve contains one port 10, which registers alternately with inlet and exhaust ports 8 and 9. The loss through friction in this type of valve, is not as great as appearances would indicate. The friction of the piston on the valve, is no greater than the friction of the piston on the walls of the cylinder; and the valve ports may be made so large laterally, that the valve does not need much travel to give a large area of opening. It will be seen that this valve also has a type of valve-gear which gives the valve a quick opening of ports.



How the "valveless" gas engine developed.

then the exhaust. The valve-gear of this valve is an interesting adaptation of this radical type of valve-gear to the gas engine; for it combines the two reciprocating motions produced by the eccentrics 15 and 17. One of these rotates at twice the speed of the other, so that the two motions are alternately added and subtracted during the cycle of operations. This gives a very quick opening and closing of the inlet and exhaust ports, while from the time the inlet is closed to the time the exhaust is opened, the valve remains almost stationary. In some cases separate slide-valves are used for the inlet and exhaust passage. All successful slide-valves of this class, as applied to gas-engines, are now of this piston type. This is due to the fact that the piston-valve is much easier to keep tight than the plain surface valve in a gas engine, in which the range of working temperature is much greater than in the steam engine. This large range of temperature tends to produce unequal expansion of the different parts of the valve, particularly where one part of the valve is exposed to the hot exhaust gases, which have a temperature of about 2,500 deg. F., The disk 13, carries a pin 14, which operates in a slot in the valve-operating lever pivoted at 15, thus giving the valve an accelerated motion during the opening of the ports, and moving the sleeve slowly during the compression and expansion strokes.

Figs. 3 and 4 show types of sleeve valves inside and outside of the cylinder respectively. In each case it will be noticed, that these valves are of a double type. Fig. 3 is the new Knight or Daimler engine. The advantages of the double-sleeve type over the single-sleeve type, lies in obtaining a quick port opening and closing, with a slow motion of the separate sleeves. In each of the engines shown in Figs. 3 and 4, the sleeves are moved by ordinary eccentrics. The increase in friction of the double-sleeve type over the single-sleeve type, is not so great as one would imagine. In fact, this type of valve is claimed by some to have less frictional loss, than the former. This is due to the fact that the two sleeves are generally traveling together in the same direction, with the exception of the time when the ports are opening and closing. The fact that the sleeves travel in opposite directions when the ports open and close also tends to do away with frictional losses, for the travel of the separate sleeves and their speed do not have to be so great as in the single type. In the case of the sleeves outside of the jacket, as shown in Fig. 4, there is, of course, a greater frictional loss than is the type of engine shown in Fig. 3. In Fig. 4 we have the combined friction of the two sleeves upon each other, and of each sleeve upon the casing, as well as the piston in the cylinder. While in Fig. 3 the friction of the piston and the inner sleeve is no greater than the friction of the piston in the cylinder as shown in Fig. 4.

Rotary valves may be classified in the same manner as reciprocating valves. We first have the ordinary rotary valves applied to an internal combustion engine. This form is shown in Fig. 5. This type of valve would give trouble from unequal expansion owing to the cool charge passing through the one portion of the valve, while the hot exhaust gases pass through another portion. A better form of engine in which rotary valves of this type are used, is one in which the valves are made of conical form and spring pressed upon their seats, separate valves being used for the inlet and exhaust.

Fig. 6 shows a rotating valve of the sleeves 27 and 28 are driven by bevel gears tion is much greater than in the case of the single-sleeve reciprocating valve. But at high speeds the effect of inertia is not evident in the case of a rotating valve, while it causes loss in the case of a reciprocating valve. The use of the double concentric sleeve-valve is not limited to the reciprocating type.

Fig. 7 shows an engine employing a double sleeve valve. In this case the sleeves 27 and 28 are driven by bevel gears 31 and 32, so as to rotate in opposite directions. We may thus cut down the speed of our valve travel, and at the same time maintain a quick port control. The use of multiported sleeves also cuts down the speed of travel so that the frictional loss is correspondingly decreased. We may also copy from the reciprocating valve engine, and place our rotating sleeve outside of the water jacket. This is shown in Fig. 8, in which the rotary sleeve, *A*, controls the inlet ports, *B*4, and the exhaust port, *B*5.

In giving a summation of the advantages and disadvantages of the above types of valves, it is difficult to know just what limitations should be given. The use of a given type of valve with any engine, depends not only upon the design of that particular engine, but also upon the character of service demanded from the engine. An aeroplane engine should differ in design from an automobile engine of the same size. The efficiency of a valve depends upon its speed of opening and closing—its waste of engine power by friction—and in the case of the reciprocating valve, the effect of inertia upon the balance of the engine. The factor of noise in operation is also to be considered.

Both reciprocating and rotating valves take more power to drive than the well known poppet valve. However, smoothness of action, speed of port opening and closing, and the ability to remain in tune, give these valves advantages over the poppet valve. It is true that both reciprocating and rotary valves require considerable lubrication, but this drawback is more than overcome by their increased efficiency over the poppet valve. The rotating valve as a rule, has a larger fric-

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Inquiry No. 9242.—Wanted, addresses of makers of bag valves.

Inquiry No. 9243.—Wanted, address of maker of Royer's monogram embossers.

Inquiry No. 9244.—Wanted, address of manufacturers making rollers, scrapers, and driers suitable for mating soap leaves.

tional loss than a reciprocating valve. To offset this, however, we have the ability to give the valve better tuning, and a complete absence of inertia effects. Inertia at high speed causes loss of power, and tends to cause vibration through lack of balance. The latter can, of course, be overcome by proper methods of balancing.

The application of reciprocating rotary valves, it is thought, will be limited to the small high speed engines. In the case of the large low speed engines, we can obtain quick port control by means of the simple poppet valve. In large engines also the valves have to be water-cooled. In the smaller engines, the internal sleeves can be made thin enough to have no material effect upon the cooling of the engine. In the case of large engines, however, the added thickness of these sleeves necessary to carry their own weight, would doubtless give trouble in cooling, and the unequal expansion, caused by the heating of those large valves, might cause them to bind.

There is no comparison between the noise of an engine using either reciprocating or rotary valves and an engine having ordinary poppet valves. The engine using the reciprocating or rotary valves, when well balanced, runs as smoothly and silently as an inclosed steam engine of the same size.

In closing this brief review of the art of reciprocating and rotary slide valves, as applied to the internal combustion engines, it might be stated that, while the number of types and forms of valves appear to be nearly complete, yet their slow adoption and appearance in practical usage, show the lack of efficiency and completeness in detail, which after all, are the essential elements which mark the line between success and failure in invention.

Oddities Encountered in the Patent Office

POPULAR superstition to the contrary, the average inventor is far from being a freak. We may talk as we will about the eccentricities of genius, but beyond a very small percentage of instances, genius is not eccentric. Eccentric individuals are encountered in every line of human endeavor, and to saddle the term haphazard upon a man just because he happens to be an inventor is an injustice which every fair-minded person must deplore. Sifted down through its various applications, the word "eccentric" appears to mean just one thing, and that is "individuality."

When it is remembered that the telegraph was invented by a man who was laughed at and regarded as a harmless "freak," and that every inventor and discoverer from the time of Christopher Columbus down to date has been encouraged by the sneers and doubts of his fellows, the inventor who is pegging along at his bench and developing his brain children, need have no misgivings because someone calls him a "freak."

Naturally ignorance is responsible for a good deal of so-called eccentricity. Man's allotted time on earth is limited. There must be things that he cannot know. A man who is ignorant of court procedure and legal forms is not hooted at by lawyers; nor do doctors make sarcastic remarks about people who have not mastered a knowledge of therapeutics. Because he does not know what you know, is no indication that a man does not know anything. There is no form of endeavor that is so exacting and requires such concentrated effort as the inventor's. Long hours and wearisome application is the inventor's lot; he toils that the world may be benefited. Like Edison, he may literally "enlighten the earth" by his efforts.

Hence the inventor should be treated with the utmost patience and consideration. The Patent Office deals with hun-

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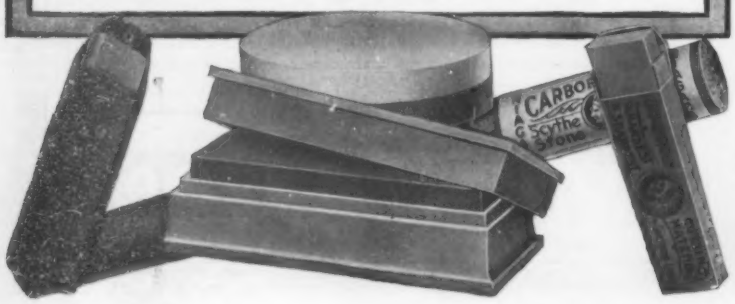

dreds of inventors every day. They write in from all parts of the globe asking to get that protection for their inventions which is the reward of their painful and arduous work. Some of these inventors are necessarily ignorant of what to do. They have been occupied in what is to them something far more important than a study of the Patent Laws. The Rules of Practice they have probably never heard of. To them the great thing has been to perfect the invention, and let the Patent Office do the rest.

All sorts and conditions of people turn their thoughts toward invention. A discovery which may seem trifling may net the discoverer many dollars and place him beyond the reach of want. It is notorious that every adult person in New York is writing a play. To test the report, a man asked the conductor of a Broadway car how his play was getting on, and the conductor instantly replied: "I have finished all but the fourth act." A successful play makes its author rich over night. It is the same with a successful invention, and the question: "How is your invention coming on?" might elicit a response like that of the street car conductor.

It would certainly seem from the vast business transacted by the United States Patent Office that the rewards for successful inventions are peculiarly attractive to mankind. Out of the huge correspondence which the Patent Office receives, a small collection has here been made of those which may be termed "oddities" in the absence of a more descriptive term. Some of these are quoted, not to prove that inventors are as a class entitled to the designation of "eccentric," but to show that genius frequently fails to find time to acquaint itself with some of the conditions which exist around it. No outsider is supposed to know by heart the ramifications of the Patent Office, and it may be said in passing that the clerks in the Patent Office cheerfully answer all letters and do their best to guide the inquiring minds into the necessary channels.

Like the country editor who announced that "it is our position not to publish news from whom we do not know who sent it" and "to insure insertions you must sign your name somewhere in the envelope so that we may know who to call upon if they attempt to shoot us," the Patent Office would be glad to have correspondents sign their names. The innocent omission of this important detail sometimes lays the office open to suspicion of neglect. In about a week an irate letter is received and the office has to grin and bear the abuse. To enter into a lengthy explanation would only waste time, and time is a precious commodity in the Patent Office.

A frequent pest is the individual who asks for copies of patents, but fails to transmit the money to pay for them. He is politely requested to send the amount, and his next letter reads something like this: "Here is the price of the three patents I ordered. Please send the patents, etc.," and the office has to dig up the original letter, which may be already filed away, in order to find out just which patents were wanted.

Some time ago a hopeful inventor asked: "Has there ever been any water-gage patented? If so, is it like mine?" That was all. It never occurred to him to describe what his water-gage was like. In view of the fact that there are more than five hundred water-gages patented up to date, the task of the office can be readily imagined. Of course the man may have an entirely new device and one which is patentable. Like the young lady who refused to let the telegraph operator read the message she wanted transmitted to her sweetheart, he is afraid to trust the Patent Office and a patent attorney with the knowledge of his invention.

Absolute frankness with the Patent Office and with one's patent attorney is as essential as it is with one's lawyer or physician. There is a pathetic side, of course, to the picture of the inventor who lives in fear and trembling lest his great secret be stolen from him. He fancies himself surrounded by spies and thinks the Patent Office is merely waiting to get hold of the invention to "tip it off" to some soulless corporation. He writes cryptic letters in which his references to his invention are veiled cautiously,

"I want to know," writes one timid soul, "whether I can have the sole right to my patent," fearing perhaps that the Patent Office will want to assume at least one-half ownership if the invention turns out to be practical. He does not know that only once in the century of the existence of the Patent Office were the ideas of an inventor stolen by a Patent Office employee, and that the employee in question spent three years in the penitentiary as a result. The strictest secrecy prevails in the Patent Office as to pending applications, and not even a man's brother, or his partner in business, much less an outsider, can get information without the inventor's written permission.

The man with the perpetual motion machine is not so frequent as of yore, but he crops up now and then. At one time the Patent Office had to make it an iron-clad rule not to consider applications for patents on devices of this kind, unless accompanied by an operative (!) model. Each case, however, is a study in itself. It eloquently bespeaks months, perhaps years, a lifetime maybe, of patient toil and worrying over perplexing problems. Each man is sure he has at last achieved perpetual motion. "I know," writes one of these, "that countless machines have been offered for patent, but mine REALLY IS perpetual motion at last!" He offers to come to Washington and demonstrate his invention, but the office has to gently, but firmly, decline the offer.

A Washington patent attorney relates an incident regarding perpetual motion that came to his knowledge. He returned from luncheon one day to find two gentlemen waiting in his office. One of them had a huge roll of blue prints, so large that the attorney had to invite them into an unused room, where the plans could be spread out more comfortably. The visitor, who was the inventor, was most eloquent. He had, he explained, an invention of a locomotive which would run by compressed air, the compressed air to be generated inside the engine itself.

The attorney who had listened patiently to these descriptions, gave a quick glance at the other visitor, who perpetrated a very decided wink. This was sufficient for the attorney, who, after some difficulty, got rid of the callers. He promised to look at the plans again at his leisure, and gravely accepted the fee of twenty-five cents which the "inventor" handed him. He dared not decline it, as he realized then that his visitor was mentally unbalanced, and that the refusal of the coin might be the signal for an outburst.

As the "inventor" had left his name, the attorney looked up his files and found that the call had been made by appointment. The man with the perpetual compressed-air engine had written for an appointment, and the attorney scenting a client had invited him to call and bring his plans. There had been no intimation in the correspondence that the man's device was of the character disclosed. The attorney had thus, unwittingly, courted a call from an inmate of St. Elizabeth's, the great asylum for the insane which lies across the Anacostia River from Washington.

The repeal of the Caveat Law has been a great boon to orthography. A young lady who answers correspondence in the Patent Office compiled a list of no less than a baker's dozen of different misspellings by correspondents of the word "caveat." The list is as follows: Cabiath;

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cavetti; caviat; caviet; cavat; caveys; cavet; cavaet; cavit; ekivet; kevats; kabiat and accadia. Luckily the law no longer permits applicants to file caveats, or it is feared the list would have been greatly swollen.

An astonishing announcement was recently received, which read: "There is a man in my town who has invented a medicine that will cure an ailment for which there is great demand." Another correspondent is still more vague. He writes:

"If not asking too much, would you kindly supply me with information concerning patents. I would like to take out a patent on a machine and would also like to find out if someone else has a patent on it."

The statement of what sort of a machine he had invented did not seem necessary to this individual. Of course the Patent Office told him how to go about getting the information he wanted, but the office does not make searches through the granted patents on behalf of inventors. This work should be intrusted to an authorized attorney. It is obvious that if the office once started to do this, it would speedily be swamped, inundated and engulfed by requests, and the clerical force would soon be doing nothing else except make preliminary searches.

It is by no means unusual to receive a request for a "list of all patents granted," nor is it infrequent that some individual wants actual copies of all the patents granted. No doubt the latter request could be complied with, if the applicant were prepared to pay for them at the regular rate, but as nearly one million patents have been issued by the United States, he would probably balk at paying the necessary fifty thousand dollars, even if Uncle Sam would undertake the carriage postage free.

During the past year a letter was received from a man who had invented a wrestling method. The half-Nelson, the strangle, and the cross-buttock were all obsolete, and he wanted to have his new method patented, he said:

"I suppose you read the accounts of Jeffries and Johnson," he wrote. "One part of the trick is that there is four holds in wrestling. One contestant does not attempt to hold on other at different twists and at certain positions, the man not holding can't be thrown. The wrestling trick I have would require pictures to show, some pictures and a mathematical system. Had Jeff employed my methods, Johnson's arms would be in splints."

Alas! this information came too late.

One inventor writes that he offered Brazil a forty per cent better navy than it now has, but does not state why Brazil refused the offer. Another tells the Commissioner of Patents to fortify the Panama Canal as much as he can. Still another avers that his invention (he does not state what it is) cannot be manufactured in the North "because black jack and cotton wood is the best to use." He evidently has no faith in the facilities for transporting lumber. The discoverer of a recipe for making pumpkin wine, claims that "it is better than using grapes." This statement might pass for what it is worth, or at least as a matter of personal taste, had not the inventor made the additional claim that "pumpkin wine is a tape-worm cure, besides."

The story of the hoax perpetrated by the mechanic who sent his green apprentice to borrow a left-hand monkey wrench was evidently not familiar to the would-be inventor who recited with great elaboration of detail that he had devised a "left-handed wheel-barrow" and wanted it patented right away.

The inventor of a turbine type of engine is all condescension when he remarks *en passant*: "I am perfectly aware there are some fast 'freak' boats on paper. Some of mine went a little further than paper." "Could heat," inquires one letter writer, "be used as light, held suspended, as in phosphorus or radium? I suppose we could then manufacture our

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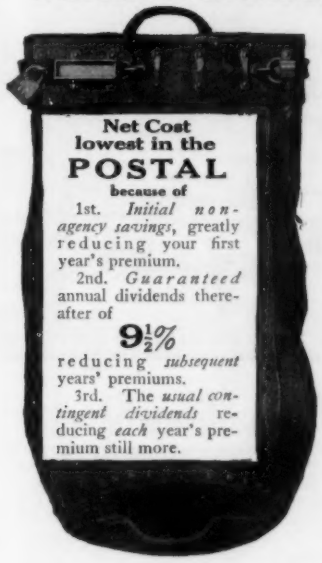
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Singular as it may seem, there is no life-insurance company in this country, outside the POSTAL LIFE, where one can secure a policy, even though he go personally to an office of the company, and not have a portion of his premium paid out as an agent's commission by that company.

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Economy, not *cheapness*, is the Company's watchword, and it lives up to all it claims.

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"*Do I understand that the POSTAL LIFE actually saves to me the usual commissions paid to agents of other companies?*" We are constantly replying that such understanding is correct; the POSTAL does this very thing; the Company saves the *first* year's commission to the agent and his *renewal* commission in *subsequent* years, credits it at once, and pays it whenever the policyholder wants it.

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"*How is the Company able to do this in view of its large advertising expense?*" The reply is that the advertising expense of the Company is not so large. It is not, as you will find upon examining the statements of other companies, even equal to what is spent by those companies simply to *help the agent* in his campaign for new business and to keep the company favorably before the public. We shall not spend this year in our magazine announcements, a sum that will require more than $1.00 out of each policyholder's premium, which is certainly not excessive. It costs very little, comparatively speaking, to get into touch with quite a large number of people interested in life-insurance.

"*Do so many actually answer your advertisements?*" They not only do so, but are most sincere, earnest and intelligent. A single advertisement occupying the usual magazine-page has brought the Company more than five hundred inquiries.

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What pleases the inquirer is that the POSTAL explains everything thoroughly in *official* correspondence, giving him personal particulars regarding policy-forms and figuring out the actual cost in his case.

The POSTAL has thus won for itself a high-grade constituency which is growing and will continue to grow as time goes on. It has policyholders in every State besides many Americans residing abroad; including those reinsured it already has more than twenty-five thousand policyholders throughout the United States and Canada.

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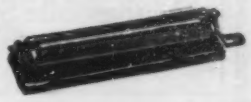

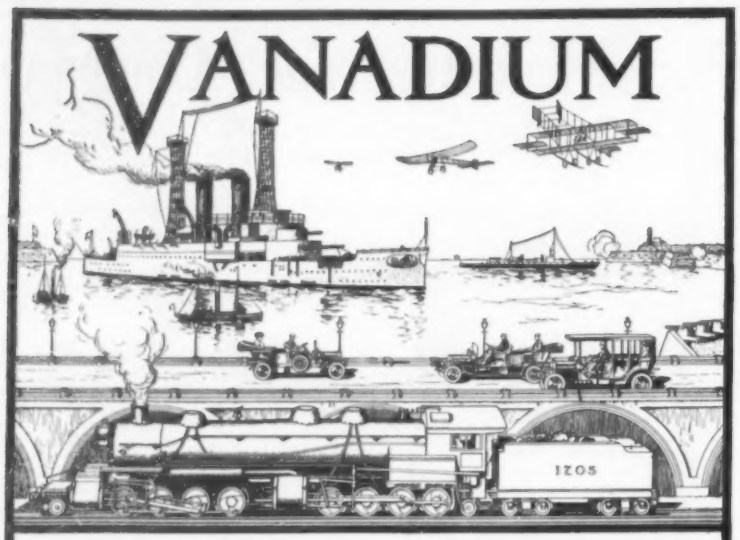

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Specify distinctly, *Vanadium Steel made from "American" Ferro Vanadium;* buy only from reputable makers, as the excellent qualities of Vanadium Steels have tempted unscrupulous dealers to use the name Vanadium for ordinary grades.

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own climate. The thing seems too big to complete," a conclusion that cannot be disputed.

"An airship propelled by the explosion of giant firecrackers" is the fancy of one inventor. This may be termed a slight modification of the internal combustion engine, but the means of locomotion thus described would form rather a weighty cargo.

A misunderstanding with regard to the citation of references is evidently the cause of the following outburst:

"Please tell why I have paid in full up to the grant of patent and then your examiner tells my attorney that my invention is forty years old or dead? Such may go with the Dutch, but it don't go with the Irish."

The *Official Patent Office Gazette*, that highly dignified publication which contains a description of every patent granted, comes in for a little "roast" occasionally. The librarian of a public library somewhere in the West recently wrote: "Please stop sending us the *Patent Office Gazette*. As only one man in the town ever read it, and he has committed suicide, we have no further use for it." Notwithstanding this unfortunate fatality, the *Gazette* continues to flourish.

Odd letters are not always amusing. There are some that are pathetic like the one received from a poor man who claimed that he had perfected an improvement in grain separators. "Heretofore," he explained, "inventors have sought to separate the grain from the straw. By my invention, I seek to separate the straw from the grain," and he went on to state that he had kept his family in poverty while developing this somewhat extraordinary conception.

The religious element, too, enters in the Patent Office correspondence. There is one persistent person who does not heed the admonitions of the office and its explanations as to how to prepare and file his application properly, but who makes on an average of once every two weeks an application written informally on a piece of fool's cap, and begins: "I, ——— of ——— most humbly pray for protection of the following inventions, and I most solemnly swear, and this in the name of God the Father, God the Son, and God the Holy Ghost, that I am their sole inventor and influenced by no one."

Another devout inventor writes: "My help comes from the Lord. He has given me this talent, and I want to make good youce of it and not keep it hid and buried in my mind. You know the Lord gave some talents to some people. The one that buried his he took from him and gave to the one that had the most, so I want to multiply mine."

A novel argument was recently advanced by an inventor in behalf of his disinclination to take the necessary oath, required by the Patent Office, to show that he was the original inventor of the device for which he applied for patent. He had no objection to declaring himself the first inventor to the best of his knowledge and belief, but being opposed to the form of oath, which requires the deponent to swear and subscribe before a notary, he quoted the Bible as his authority.

Matthew v. 34 is his citation. "Swear not at all," and also verse 37 of the same chapter, which reads: "But let your communications be Yea, Yea, or Nay, Nay; for whatsoever is more than these cometh of evil."

As a clincher to this argument against the Patent Office oath, the inventor in question contends that "a righteous person will not intentionally tell a lie under any circumstances; you may swear a liar forty times, and it would not make him tell the truth. You can't make a liar tell the truth, neither can you make a Christian tell a lie. Am I not right?"

The writer was informed that his scruples against swearing were respected by the office and that he might, if he so desired, simply affirm the fact that he was the inventor of the device offered for patent.

While instances have been given of genuine letters from inventors, it may be interesting to quote a "fake" letter which was written by a patent attorney as a joke on one of his associates. It appears that this attorney's associate devoted his time mainly to the task of searching, and like many who spend a great deal of time among the records of granted patents, whenever anything was shown to him, he had a strong impression that he had seen something of the sort before. In fact he had seen so many inventions that hardly anything seemed new to him.

The patent attorney referred to took it into his head to test the recollection of this chronic searcher. Accordingly he prepared a "fake" communication and had it properly stamped and placed on his associate's desk. The letter was directed to the firm and proceeded to set forth that the writer had always been a student of languages, and in the pursuit of such studies he had discovered that there was a mechanical relation between the different tongues, French, German, English, Spanish, etc. In developing this discovery, the writer went on to say, he believed that he had invented a machine by means of which one language could be mechanically translated into another. He proposed, by means of slides or disks placed in the machine, to translate French into English, German into French, and so on, according to the position of the slide in the machine. For instance, one side of a slide being uppermost would translate French into English; reverse the slide and the English would be translated into French. The "inventor" desired to be informed whether the idea was new, and asked advice on having it patented.

The man well versed in the searching of patent records read the letter through very carefully, turned to his partner, and said: "Here's something great! The trouble is it is not new; I remember having seen something like it before."

To return to the realm of absurd realities, it may be well to conclude this brief recitation of Patent Office oddities with the following story:

A be-whiskered individual wandered into the Commissioner's office one day and inquired if that was the place where patents were given out.

"This is the Patent Office," replied the clerk addressed. "What can we do for you, sir?"

"Well," explained the visitor, "I'm a stranger in Washington. Just passin' through, and I thought I'd stop off and get one of them patents, if you'll be so kind as to give me one."

Suppressing his inclination to smile, the clerk asked: "What is your invention, sir?"

"Oh, I haven't invented anything, yit," returned the caller, stroking his luxurious beard meditatively, "but I thought it might be handy to have a patent ready in case I did invent something some time."

Notes for Inventors

The Air Propeller an Old Device.—The automobile with a propeller similar to that of a flying machine driven by the automobile engine and operating in the air to propel the automobile finds its prototype in two expired patents, one issued August 22nd, 1871, for a boat designed to be propelled in the water by an air propeller driven by its engine, and the other issued July 25th, 1876, for an automobile whose engine may be caused to drive either of two air propellers, one of the latter moving the automobile forward and the other backward.

Making Barrels by Machine.—Hand cooperage is now almost an extinct industry. In no department has wood-working machinery been more highly specialized. There are machines for working

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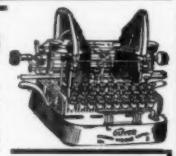

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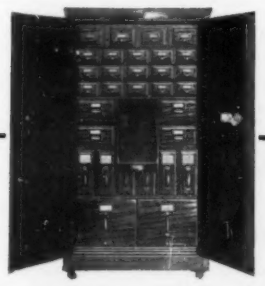

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the staves, for making the hoops, for shaping the heads, for assembling the parts, and for finishing the barrels. In a new machine for pressing the hoops round casks by hydraulic pressure, magnetized rings hold the hoops clear until the casks are raised to the exact position to receive the hoops. Another ingenious machine automatically chamfers the ends of the staves, cuts the grooves for the heads, saws them to an equal length, runs them through a printing machine, if they are to receive numbers, names or devices, and finally sends them through a drying oven.

Safety Devices on Railroads.—As interesting to railroads and common carriers generally, we note an order of the Interstate Commerce Commission of March 13th, 1911, extending the period within which the requirements of the act to supplement an act to promote the safety of employees and travelers, etc., shall be made effective. Thus the order extends the time governing the certain specified changes in freight train cars for five years from July 1st, 1911; for the changes in passenger train cars for three years from July 1st, 1911; for the changes in switching locomotives for one year from July 1st, 1911, and for the changes in locomotives other than switching locomotives for two years from July 1st, 1911, the order including certain modifications in the extensions relative to repairs or rebuilding of the cars as more definitely set out in the order in question.

The Scientific American in the Patent Office.—A principal examiner of the Patent Office, speaking in appreciation of the descriptions and illustrations of novel mechanical devices in the SCIENTIFIC AMERICAN, referred especially to their value to the Patent Office examiners as citations against applications for patents. He suggests the advisability of classifying clippings from the publication, which could be done to advantage in the classification division, and distributing the classified clippings to the appropriate examining divisions. An attorney representing a well known aviator before the Patent Office, also in discussing the same subject, spoke of the importance of some citations made by the Patent Office of SCIENTIFIC AMERICAN illustrations in the field of aviation.

Commissioner Butterworth's Wit.—Ben Butterworth in his service in Congress and as Commissioner of Patents, was noted for a remarkably ready wit. He was once opposed in a suit by an attorney, Tom Wood, and considerable bad feeling had developed between counsel. His client tells that on one occasion when in conference with Mr. Butterworth, they heard Wood was dead, and immediately Mr. Butterworth said: "I would suggest an epitaph for him and it would read like this:

"Here lies the body of Tom Wood,
One wood within another,
The outer wood we know is good,
But are doubtful of the other."

A Bit of Patent Office History.—Prior to the Patent Office fire in 1877, which burned a large portion of the models then filed and destroyed the integrity of the collection, it was the custom of attorneys to make examinations of the models to determine the novelty of inventions submitted to them. The drawings were not then available to the public as now. On one occasion an attorney accompanied by the inventor found a model which fully met the inventor's idea. After this was determined and they had left the model case, the inventor who had lagged behind said to the attorney, "Well, they will never find that any more;" and when asked what he had done, said, "I threw it on top of the case where they will never get it." Of course that made no difference, as the Patent Office examiner made his examination in the complete set of drawings provided for such purpose.

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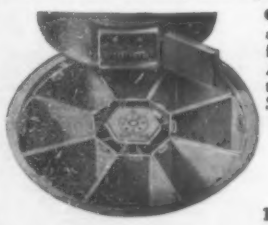

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Aeroplane Propellers

(*Continued from page 469.*)

propeller will be about 3½ to 5 feet, while on a machine like the Wrights', the revolutions of the propeller would be about 400 and the pitch about 11 feet. Now the friction and head resistance of the propeller blades passing through the air vary approximately as the square of the velocity. If the two propellers each had a diameter of 8 feet the mean velocity of the blades of the small pitch propeller through the air would be about 2.8 times as great as that of the large pitch propeller, and the loss of power resulting from friction and head resistance would be about eight times as great.

For this reason it is desirable to make the pitch large and keep down the revolutions as compared with the speed. On the other hand, if the pitch is made too large the air is pushed around sidewise instead of being pushed to the rear, and as such motion of the air does not produce thrust excessive power is lost in that manner. With air propellers, as with marine propellers, it has been found that the best pitch is from 1.2 to 1.5 times the diameter.

There is also a practical disadvantage in making the pitch large, and this is that the starting thrust, before the aeroplane has got up to speed, is considerably less than with finer pitch propellers. Curiously enough, some experimenters and also makers of propellers conclude that because a stationary test of a propeller gives a large thrust per horse-power, the propeller is necessarily efficient when moving through the air. *The exact contrary is apt to be true.* In the stationary test, the propeller acts as a fan, and the more air it pushes to the rear the greater the thrust. When it is on an aeroplane moving through the air the conditions are reversed, and what is wanted is a propeller to push the aeroplane ahead and not a fan to push the air to the rear. In other words, a good fan is not likely to be a good propeller.

Material and Number of Blades.—With few exceptions aeroplane propellers are now made of wood, and usually with two blades only. On account of its lightness, ample strength, and ease of cutting to shape, wood is much more convenient material than metal. The use of wood has no doubt contributed largely to the almost universal use of but two blades, as they can be cut from a straight piece without introducing joints at the hub, as is necessary when more than two blades are used.

At first thought it might appear that if three or four blades are used 50 or 100 per cent more thrust would be obtained. In fact, in a recent annual publication dealing with aeronautics there is an article arguing that six blades and possibly more are best. Possibly this idea is due to considering that an air propeller is only a windmill reversed. In the absence of reliable data on the subject it is probably safe to assume that in this respect the facts are likely to be the same as found for marine propellers. With them it has been found that for efficiency the fewer the blades the better, and that two blades are best. It has also been found that for identical propellers, except that one had two blades and the other three, the increased thrust for the latter, when running at the same speed through the water, and with the same number of revolutions, was about 20 per cent only, while the increase in power required was about 23 per cent.

The reason why three or four blades are usually used for marine propellers is because they are usually restricted in diameter by the depth of water over the tips and the size of the vessel, and it is necessary to have more than two blades in order to get the desired thrust. Another reason is that two blades are likely to produce more vibration.

With the aeroplane the restrictions as to size are not so great, and vibration due to motor or propellers does not yet seem to have caused any considerable inconvenience. Both from a practical standpoint and for efficiency the two-bladed wooden propeller seems best.

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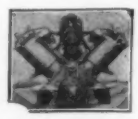

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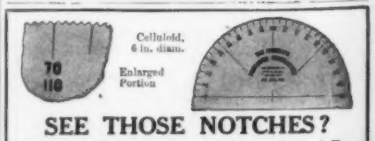

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1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the GOULD-SCIENTIFIC AMERICAN Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horse-power, fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the SCIENTIFIC AMERICAN on or before June 1st, 1911. Contests will take place July 4th, 1911, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the SCIENTIFIC AMERICAN, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control, and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced on or about June 1st, 1911.

VICTORY

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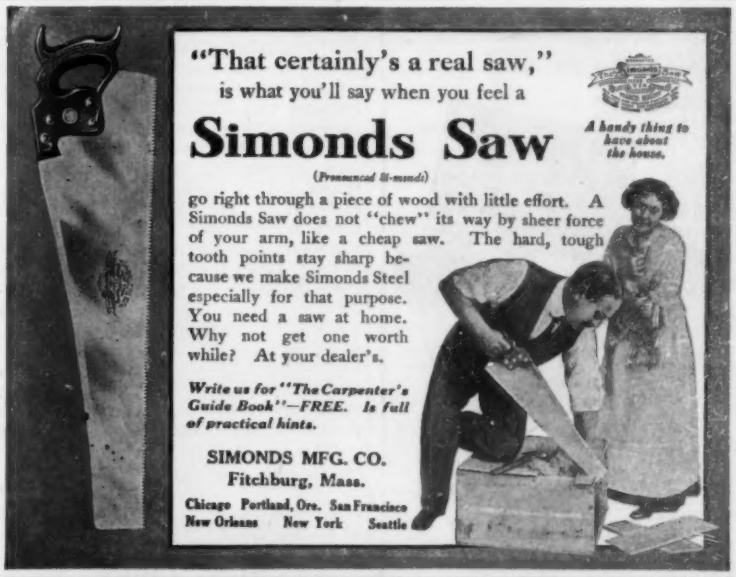

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Octave Chanute

(*Continued from page 468.*)

Mr. Chanute forwarded a quantity of aeronautic literature, visited the camp at Kitty Hawk, North Carolina, where Wilbur Wright and his brother Orville made their first glider experiments, and continued their steadfast mentor till they had transformed the glider into a true dynamic aeroplane.

Similar counsel and friendly sympathy was extended to some of the pioneer aeroplanists in Europe, who likewise succeeded ere long in powering the Chanute glider and transforming it into a successful dynamic biplane. In fact during the first decade of the twentieth century the development of the light gasoline engine had advanced so far that every clever mechanic who had money enough to procure a good one, of the Antoinette pattern, for example, could power a Chanute biplane and fly in fair weather. This was well shown by several brisk young men in France, and in particular by the famous aeronaut, Santos-Dumont, who, without special preliminary training in aviation, and while others were cautiously studying safe methods, suddenly bolted into the air on a crude biplane, and navigated over the heads of his astonished friends by sheer audacity and awkwardness, but ably seconded by his marvelous Antoinette motor.

One naturally inquires why Mr. Chanute did not achieve that easy renown. The reason was simply that when a light motor was first available he had passed three score and ten. He was now too old to ride an experimental aeroplane and too scrupulous to invite any one else to take such a risk. He had completed his important pioneer work and was serenely watching the younger generation of men as they appeared on the scene one by one, then by scores, to enjoy the fruits of his labor and that of his confrères, Lilienthal, Pilcher, Langley and others who had helped to prepare the way for final success.

Before his death on Thanksgiving Day, 1910, Mr. Chanute had seen his most sanguine dreams more than realized. Flyers were traveling from city to city at more than railway speed; sweeping over vast stretches of water and unknown territory, guided through fog and tempest by the simple mariners' compass; soaring like eagles above the rain clouds and in regions white with frost; racing over the Alps; contending in great tournaments; maneuvering with armies as a serious adjunct of the great military establishments of the world. He did not live to see an aeroplane rise indifferently from land or water, nor to see a dozen passengers in one machine, nor an aviator of less than a year's training fly without pause from London to Paris, through fair and foul weather, at more than a mile per minute; but these things he could easily anticipate, and much more that still remains to be accomplished.

One favorite dream of his that still remains unrealized is the achievement of soaring flight. He was convinced that the great vultures, gulls and powerful birds of prey can in favorable weather ride the wind for hours without wing-beat or the expenditure of propulsive power. Indeed, one incentive to his gliding experiments was the hope to promote the art of human soaring. And one of his latest papers published in *Aeronautics*, two years before his death, demonstrated the feasibility of soaring in a wind having an upward trend of three to four feet per second. He wished to have young men take up gliding as a sport in those localities favorable to such art, particularly where a steady breeze flows up a sandy slope by the sea, hoping that they might eventually acquire something of the art of the condor and the albatross. Perhaps ere long that dream, too, may be realized, when the talented volplanists of the present hour turn from their dynamic machines for a vacation's contest with the vultures and the gulls.

The foregoing is but a partial glimpse of Mr. Chanute's ceaseless activity in aviation during the last twenty years of his life. His most arduous, and next to the glider experiments, perhaps his most effective efforts were exerted to stimulate or assist others. He wrote substantial and numerous letters to those in need of his valuable counsel; in his varied travels at home and abroad he would visit and personally cultivate those who were earnestly studying his favorite science. Unostentatiously and unknown to the world at large, he gave financial aid to several hard working observers or experimentalists in various countries. Often fifteen thousand dollars, in one form or other, was thus given to the promotion of aviation without prospect of return, not to mention many times that amount of his valuable professional time. Thus by virtue of his own inventions and researches, and by virtue of his most generous and sympathetic assistance of all earnest votaries of the art, he has doubly merited the title sometimes applied to him by his countrymen—"The Father of Aviation."

Unhappily for those who appreciated his work, no very adequate or formal recognition of his earnest and important labors in aeronautics was made by his countrymen during his lifetime. This perhaps is due to the fact that he was taken from their midst so shortly after the science of mechanical flight began to assume great value in the general estimation. It is to be hoped, however, that ere long his countrymen will establish a suitable memorial of his long devotion and fine achievements in a science of such fascinating interest and untold possibilities for humanity.

Automatic Stability of Aeroplanes

(*Continued from page 471.*)

structure with the line joining the tips of any pair of wings passing behind the center of gravity, and the angle of incidence gradually decreasing until at the tips it is decidedly negative, is one that probably holds a very good key to the solution of the problem of automatic stability.

The common dihedral angle of the two halves of the main plane to each other and of the main plane to the keel or tail as excellently exemplified on the Antoinette, also gives a measure of automatic stability that is now widely understood.

VI.

Sir Hiram Maxim, on October 25th, 1889, in England, patented a device whereby the difference in the pressure of the atmosphere on the roof of a box causes a movement not unlike that of the diaphragm of an aneroid barometer, which is communicated by a delicate mechanism to the motor feed and by the regulation of the motor keeps the altitude practically constant.

On December 31st, 1895, E. J. Pennington patented in England a still more interesting device in which the electric motor and worm gear drive of the elevation rudder is controlled by means of the index finger of a barometer so as to maintain the aerial vessel at a predetermined altitude. In addition the motor and worm gear operating the rudder for direction is controlled by the movement of a compass needle which, by means of electric contacts, causes the motor to turn the rudder so as to keep the machine on a steady course.

Such devices are highly ingenious, but their practical worth is still to be determined.

Earle Ovington's Blériot

MR. EARLE OVINGTON, who is flying almost every fine day in Long Island, has brought to this country the first of the new 1911, 70 horse-power Blériots. The machine is fitted with a new seven-cylinder Gnôme motor, the first of which was made by the Gnôme Company for Blériot's passenger machine, and the second for Farman. Mr. Ovington's Blériot has the new inverse curve tail, which will characterize all the 1911 single-place Blériot monoplanes.

Mr. Ovington is an engineer, and has had special features incorporated, principally to strengthen the construction. Instead of the four steel straps under the wings, he has had six fitted. Two extra main spars run the whole length of the wings. There are just twice as many ribs as in the wings on the ordinary 50-horse-power Blériots. Every control wire on the machine is in dupli-

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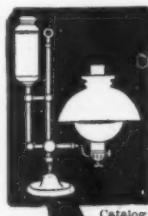

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cate, even the rudder wires. The wires which warp the wings are also special large size stock. Unlike any of the older Blériots, there is just a single V-shaped support for the upper wing wires, instead of the much clumsier double-V support formerly used. The engine, tanks and controls of the machine are entirely covered by a long, sloping hood which acts as an efficient wind shield and adds greatly to the appearance of the machine.

Mr. Ovington has fitted his machine with every useful accessory that he could lay his hands on in the Paris aviation shops. As he sits in the machine, in front of him he has a map holder so arranged that by simply turning a knurled wheel he can move the map as the country passes under him. Similar map holders are made in this country for automobile use. The map unrolls from one cylindrical rod and rolls up on another. It has a glass cover for protection, and is of aluminium throughout. The usual electric speed counter is also provided to notify the aviator at all times of the number of revolutions per minute made by the engine. To the right of the aviator's seat is a level indicator, an ingenious device containing a red liquid in a triangular glass tube inclosed in aluminium. It tells the aviator whether he is climbing, falling, or flying horizontally. It is also valuable in adjusting the tail planes. To the left of the aviator is an altimeter, or aneroid barometer, which indicates the altitude. This is calibrated as a regular barometer on the innermost scale, as an altitude meter on the next scale, while the outer scale is movable with a screw on the side, so as to mark the maximum height recorded without the necessity of carrying a barograph or recording barometer. The device is so sensitive that the difference in height in going up one small flight of stairs is recorded. On the steamer which brought Mr. Ovington to this country, the instrument recorded the rise and fall of the stern of the boat without difficulty. Between the aviator's legs on the floor is a universally hung compass of the glycerine floating type, which Blériot has found the only reliable one for aeroplane use.

Aeronautic Wireless Telegraphy

By Percy G. B. Morriss

THAT wireless telegraphy is the complement of the military aeroplane can no longer be doubted, and since the successful demonstration of the transmission of messages by this means at Sheepshead Bay in 1910 from a Curtiss biplane to a field station, both military and aviation experts have been turning their attention to the possibilities of receiving messages when aloft with a like success. The chief problem that has confronted those interested in this work has been in providing a suitable antenna for the aeroplane end of the circuit, and the satisfactory disposal of the same. In the attempts made on the Pacific Coast last year the army officers experimenting obtained their best results in transmitting by using a hanging antenna. The experimenters in this case took aloft a 200-foot coil of fine copper wire which was let out and allowed to dangle toward the ground as soon as sufficient altitude was attained. When the experiments were completed, or when the aviator was about to return to earth, the wire was cut.

There are many reasons why this method is not practicable, among which might be mentioned that the system carried is totally useless unless the machine is at least two hundred feet above the tops of the tallest obstructions on the ground; and that really good results will never attend any installation which imposes an antenna between the "artificial ground" in use and the earth itself. Again, a hanging wire of any description is a constant source of danger both to the machine and its occupants, owing to the liability, through the suction of the propeller, of its becoming entangled in the shaft or in the propeller itself. The cost of 200 feet of copper wire for every few minutes' conversation must also be considered, as must the weight of each coil carried to be let out and dropped as desired.

In the beginning of March, 1911, the writer co-operated with Mr. J. A. D. McCurdy, who was flying a Curtiss biplane at Palm Beach daily, and carried out several experiments with a view to inventing some means whereby the hanging antenna favored by the army officials could be entirely dispensed with. In these he was also assisted by Mr. George W. Hoey, an electrician of Philadelphia, whose experience in the First Engineer Corps during the Spanish-American war proved of no little value in determining the best method of installing wireless apparatus for military reconnoitering and courier service. On March 6th, satisfactory results having been obtained with an exceptionally light and small Marconi transmitting set, to which was attached a loop antenna of flexible insulated wire tightly stretched from strut to rudder supports, attention was turned to experimenting with antennæ placed in similar positions for the reception of messages. In the transmitting tests Mr. McCurdy himself operated the set by means of a key attached to the steering wheel of the machine, but in this case it was deemed necessary to have the services of an experienced operator. To this end a light seat was fastened on the bottom plane of the machine close to the engine, and the writer, accompanying the aviator, was successful in receiving readable signals from many stations far distant.

In these experiments a Marconi magnetic detector was used and connected on the "ground" side to the metal framework of the machine, which, used in series with a number of small plates of tinfoil, formed one side of a condenser of which the earth itself made the other. To the "aerial" side of the detector was attached 150 feet of 25-No. 28 rubber covered wire, which was wound from the end struts of the machine around the after rudder frame and back several times. In order to reduce any local interference that might be experienced from the noise of the unmuffled exhausts or from the intense rush of air, a temporary head-dress was improvised out of a face towel, handkerchiefs, and cotton wadding, the whole being tightly bound around the head over the telephone receivers with tire tape. The detector and tuning apparatus was carried on the knees of the operator, who experienced absolutely no difficulty in adjusting with one hand and in writing with the other.

Immediately the machine left the ground, signals from Key West Naval Station became distinctly audible through the telephones, as did the signals from the station at Havana, 300 miles distant, in answer to Key West. At a height of about 1,000 feet, signals of an extremely high tone were heard, but the purport of whatever message was being sent was lost owing to the "jamb" from Key West. From the tone of these signals it is thought that they probably proceeded from a Fessenden set on some United Fruit boat, the nearest of these, working at that time, being in the vicinity of Panama. When an altitude of about 1,500 feet was reached other high-frequency signals were heard which seemed to come from some vessel in closer proximity than any other station. Owing to the noise of the engine and the "jamb" from Key West, these signals were also unreadable, but were found to have proceeded from the U. S. M. S. "New York," which was on a winter cruise around the West Indies. An hour after the experiments took place a message was received from the operator of this vessel asking if his signals had been heard, and stating that he had been calling "D S" (the call letters assigned to the biplane) all the afternoon, anticipating a reply. Had the protection from local disturbances been more efficient, better results would have unquestionably been obtained.

Now that the simplicity with which a small wireless set may be operated on heavier-than-air machines while in flight has been successfully demonstrated, there is every indication that a compact and light outfit will shortly be one of the most important parts in the equipment of the war aeroplane, and it is only reasonable to suppose that the military plane of the future will be a single-seater, carrying one man trained both in aeronautics and in wireless operating.

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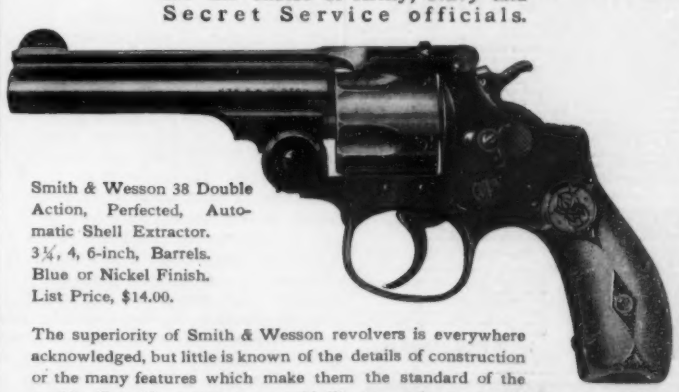

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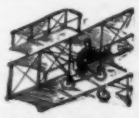

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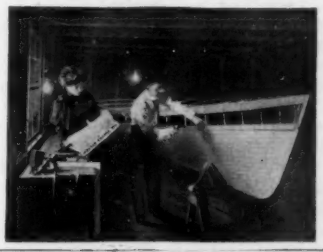

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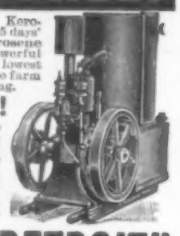

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Saccharin in Food

AT the request of the Secretary of Agriculture, the Referee Board of Consulting Scientific Experts has conducted an investigation as to the effect on health of the use of saccharin. The investigation has been concluded, and the Referee Board reports that the continued use of saccharin for a long time in quantities over three-tenths of a gramme per day is liable to impair digestion; and that the addition of saccharin as a substitute for cane sugar or other forms of sugar reduces the food value of the sweetened product and hence lowers its quality.

Saccharin has been used as a substitute for sugar in over thirty classes of foods in which sugar is commonly recognized as a normal and valuable ingredient. If the use of saccharin be continued it is evident that amounts of saccharin may readily be consumed which will, through continual use, produce digestive disturbances. In every food in which saccharin is used, some other sweetening agent known to be harmless to health can be substituted, and there is not even a pretense that saccharin is a necessity in the manufacture of food products. Under the food and drugs act articles of food are adulterated if they contain added poisonous or other added deleterious ingredients which may render them injurious to health. Articles of food are also adulterated within the meaning of the act, if substances have been mixed and packed with the foods so as to reduce or lower or injuriously affect their quality or strength. The findings of the Referee Board show that saccharin in food is such an added poisonous or other added deleterious ingredient as is contemplated by the act, and also that the substitution of saccharin for sugar in foods reduces and lowers their quality.

The Secretary of Agriculture, therefore, will regard as adulterated under the food and drugs act foods containing saccharin which, on and after July 1st, 1911, are manufactured or offered for sale in the District of Columbia or the Territories, or shipped in interstate or foreign commerce, or offered for importation into the United States.

A Dictionary of Aeronautics

THE Technical Words Committee, which has been constituted by the Aeronautical Society of Great Britain for the purpose of standardizing aeronautical terminology, has just issued the following preliminary report:

In view of the somewhat confused state of aeronautical terminology at present prevailing a Technical Words Committee was appointed by the Aeronautical Society of Great Britain to draft a list of technical terms relating to aeronautics, and to define their meaning. The work of the committee has proceeded along systematic lines, and has already resulted in the compilation of a glossary of the more general terms in use. It was decided, therefore, to issue this list forthwith in the form of a preliminary report, as it fairly well covers the technical vocabulary involved in the ordinary course of aeronautical work. Since uniformity in this matter is essential, it is hoped that all writers on aeronautical subjects will generously sink individualism where necessary by co-operating in the systematic use of the following terms. In due course the committee hope to issue a glossary covering the whole range of aeronautical terminology, but the work of selection and definition is necessarily slow when conscientiously undertaken. The committee wish to draw attention to the fact that they have aimed at making their definitions of technical terms as simple and commonplace as possible. The definition of ordinary dictionary words that are sometimes used technically has, as far as possible, been avoided, in order to give that latitude of expression so much desired by all writers. In a few cases where certain words are used in contrary senses by different schools of writers—such as "aerodrome" and "airship"—the committee have been forced to take arbitrary action; it is particularly in respect to the use of such words that the committee hope to meet with the support of the public.

GENERAL TERMS.

AERONAUTICS—The entire science of aerial navigation.

AEROSTATICS—The science of buoyancy in air by means of displacement; this is, therefore, the term to be applied to the science of aerostation.

AERODYNAMICS—The science relating to the effects produced by air in motion; this is, therefore, the term to be applied to the science of aviation.

AEROSTATION—That part of aerial navigation dealing with gas-borne or "lighter-than-air" machines.

AVIATION—That part of aerial navigation dealing with dynamically-raised or "heavier-than-air" machines.

AERONAUT—One who practises any branch of aerial navigation.

AVIATOR—One who practises aviation.

PILOT—An aeronaut qualified in aerial navigation.

ENGINEER—In charge of the power-plant.

HELMSMAN—In charge of the steering.

SHED—The use of the term *shed* is recommended instead of *hangar*.

HARBOR—A natural or artificial shelter.

AERODROME—A ground set apart for flying purposes. The committee do not recommend this term, but, in view of its somewhat general use, suggest that it should be employed only in the above sense. This suggestion is made without prejudice either to its derivation or to its application in another sense by authors such as Langley, Lanchester, and Graham Bell.

DIRIGIBLE—A power-driven balloon.

AIRSHIP—This term having occasionally been used to denote *aeroplane*, the committee recommend its use only in the sense of *dirigible* in order to avoid confusion.

HELICOPTER—A flying-machine supported by one or more screw propellers on vertical or approximately vertical shafts.

ORNITHOPTER—A "flapping-wing" machine.

FLYING-MACHINE—A general term denoting machines used in aviation as distinct from those employed in aerostation.

AEROPLANE—A flying-machine provided with fixed planes supported dynamically by its movement through the air. This term should *not* be used to denote the planes themselves, but should only apply to the whole machine.

GLIDER—An aeroplane unprovided with motive power.

MULTIPLANE—An aeroplane with two or more main planes overlapping in plan-form.

BIPLANE—An aeroplane with two superposed main planes overlapping in plan-form.

MONOPLANE—An aeroplane with a single main supporting plane, which may consist of a pair of wings outstretched on either side of a central body.

TANDEM, STEPPED—In some cases aeroplanes have more than one pair of wings, which may or may not be on the same level; such planes, if they do not overlap in plan-form, must necessarily be arranged in "tandem"; when not on the same level they are said to be "stepped." For instance, "an aeroplane having three pairs of wings stepped in tandem."

PRINCIPAL DIMENSIONS.

AREA—This term is not a technical definition unless qualified by an adjective, as, for instance, "supporting" or "effective" area. By area is meant, in the case of planes, the area of the plan-form, and is therefore measured in units of double surface. That is to say, both sides or surfaces are counted as one unit of area. Thus, by an area of 500 square feet is implied a surface of twice 500 square feet.

SURFACE—Attention is drawn to the distinction that exists between surface and area. See AREA.

WEIGHT—This being a general term, should only be used when qualified by an adjective, such as "net weight."

NET WEIGHT—The weight of the complete machine *exclusive* of variable quantities, such as pilot, fuel, lubricants, etc.

GROSS WEIGHT—The weight of the complete machine inclusive of all variable quantities, i. e., pilot, fuel, lubricants, etc.

LOADING—The loading of a machine is

Important and Instructive Articles on Aviation

IN the *Scientific American Supplement* we have published in the past few years papers by some of the more eminent physicists and engineers on flying machines. No book thus far published is so complete and so authoritative as these articles. The range of the articles is wide, covering as it does the theoretical side of aviation as well as those more practical aspects which deal with the construction of machines. The following is a partial list of the more important articles which have appeared in the *Scientific American Supplement*; see special note below.

¶ 1816, 1817, 1818, 1819, 1820, 1821 and 1822. **The Practice and Theory of Aviation.** By Grover Cleveland Loening, A. M. This is the most compact paper on aeroplanes that has probably ever been published. Fourteen biplanes and monoplanes are described in detail, and illustrated with scale drawings, namely, the Farman, Cody, Curtiss, Wright, Voisin (old model), Voisin (new model), and Sommer biplanes, and the Antoinette, Santos-Dumont, Bleriot XI, Bleriot XII, Grade, Pelterie and Pfitzner monoplanes. The proper dimensioning of aeroplane surfaces, as deduced by famous experimenters from their tests, is also considered. Taken as a whole this series of seven papers constitutes an admirable text book.

¶ 1713. **The Wright Aeroplane.** This is a thorough description of the old type of Wright biplane with the horizontal elevation rudder in the front of the machine. Excellent diagrams and photographic views accompany the paper.

¶ 1756. **Louis Blériot and His Aeroplanes.** Few people realize that Bleriot's successful monoplane is the result of ten years of daring and perilous experiment. In this paper will be found an instructive description of the evolution of the present successful Bleriot monoplane, illustrated with diagrams and photographs.

¶ 1768. **The Farman Biplane.** A complete description of the Farman biplane, with detail drawings of the box tail and vertical rudders, the manner of working the four ailerons, hand and foot levers which control the machine, plan view and side elevation of the entire machine.

¶ 1767. **The Santos-Dumont Monoplane.** An illustrated article describing the Demoiselle, the smallest and one of the fastest machines thus far made. Sketches accompany the article, showing the details of the construction and control.

¶ 1582. **How to Make a Gliding Machine.** Full details and drawings which will enable anyone to make a glider for $15.00.

¶ All these articles are profusely illustrated.

¶ Each number of the *Supplement* costs ten cents, mailed, and you can order as many of them as you wish. A set of papers containing all the articles above mentioned will be mailed for $1.20.

SPECIAL NOTE

¶ We will mail [gratis] a list of many additional important papers, in the *Supplement*, treating of aeronautics. Ask for list A

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At the recent Cement Shows in New York and Chicago great interest was created by a pyramid of highly colored, polished oblong stones. There were specimens of white, gray, pink, red, yellow, orange and brown, and in fact many shades and combinations of colors, and of a character which no one had ever seen.

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its gross weight in pounds divided by the supporting area in square feet.

PRINCIPAL PARTS.

PLANE—Any element of area used for dynamic support or control. In pure aerodynamics the term should only be used with a qualifying adjective such as "flat," "curved" or "chambered." The prefix "aero" is restricted to the complete machine defined as an "aeroplane."

WING—The present use of this term, by analogy with natural flight, denotes each of a pair of planes outstretched on either side of a central body, which wings, if continuous, would form a single plane.

BODY—In flying-machines, the central longitudinal framework to which the planes and organs of control and propulsion are attached.

CARRIAGE—That part of the machine beneath the body intended for its support on land or water.

TAIL—In flying-machines, a plane or group of subsidiary planes, which may include both horizontal and vertical planes, behind the main planes.

ELEVATOR—A movable plane or group of planes for directing and controlling the machine vertically.

RUDDER—A plane or group of planes for guiding a machine to right or left.

BALANCER—In aeroplanes, an organ—usually a plane—for maintaining lateral equilibrium.

Cigarette Paper

OF the great army of cigarette smokers there is probably not more than one in a hundred who knows that rice paper, in which the tobacco is wrapped, has nothing to do with rice, but is made from the membranes of the breadfruit tree, or, more commonly, of fine new trimmings of flax and hemp. So light is this paper that 500 of the tiny sheets go to make an ounce. They are perfectly combustible and give off the minimum of smoke. Before being rolled with tobacco they are analyzed to prove that they are free from all deleterious ingredients and that they contain nothing but the purest paper fiber. Only new material—flax and hemp trimmings—is used, and these are thoroughly purified. Chopped by machinery into minute particles, they are well mixed by a revolving fan, and then reduced to a dust, which is placed in a solution of lime and soda. After remaining in this solution for some time, in order that all foreign substance may be eliminated, it undergoes a thorough washing process, the water being the purest kind coming from artesian wells sunk especially for the purpose. Then the pulp is rolled out into paper. At first it is of a grayish tinge, the pure white of the finished product being obtained by an electric process, which in bleaching it also cleans it of whatever impurities might have escaped the bath.

The French manufacturers of cigarette paper practically supply the entire world, the output of Austria and Italy being insignificant.

A Great Atlas of Zoogeography

SOME twelve years ago there was launched at Edinburgh, under the patronage of the Royal Geographic Society, one of the most ambitious undertakings in the history of cartography, viz., Bartholomew's "Physical Atlas." Of the many volumes projected, only one (Vol. 3, "Meteorology") had seen the light up to the beginning of the present year. Now another has appeared, viz., Vol. 5, "Zoogeography." The new volume bears the same relation to the previous literature of zoology as did its predecessor to that of meteorology. It takes its place at once as the most complete and authoritative cartographical treatment of the subject; and, from the point of view of science in general, it is one of the reference books that henceforth no important scientific library can afford to be without. The work contains 36 plates and an extensive text, the latter including a bibliography of 11 folio pages. The workmanship is on a par with that of the Bartholomew publications generally; that is to say, it is both accurate and beautiful.

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$ 5,000	can earn annually				from $3,000	to	$ 6,000
7,500	"	"	"	"	4,500	"	9,000
10,000	"	"	"	"	6,000	"	12,000
12,500	"	"	"	"	7,500	"	15,000
15,000	"	"	"	"	9,000	"	18,000

Larger or smaller sums will earn profits in proportion, and the original investment adequately secured with property constantly increasing in value. "If such investments exist, why are they advertised? Why don't moneyed men grab them?" The answer is, they are grabbing them just as rapidly as occasion permits. Such investment opportunities are rare in many respects and their existence can only be made known by some form of advertising. Dozens and even hundreds of investors have grown independently rich, and many wealthy men who wish to retire prefer this form of investment to all others because of its safety, certainty of very large profits and personal freedom from care and responsibility.

This particular opportunity has its limitations, in that only 100 investors at most can be accommodated, and they must act at once

How It Is Done. The best fruit lands of California, Idaho, Washington, Montana and elsewhere in the west where the world's fancy fruits are raised, is found in the valleys and at the base of mountain ranges. This latter land is best because it has the accumulation of the rich mountain soil washed down for ages. It is called "bench land" and when irrigated and set to fruit, it produces the prize products which sell for fancy prices at home and abroad.

There isn't an unlimited acreage of such land and it is worth raw a high price per acre—when cultivated and irrigated it becomes worth $500 to $5,000 per acre.

The permanent value of such property and the enormous profits it yields, is attracting the attention of those who wish their independence assured and the man or women who can own five or ten acres has no cause to worry for the future.

The Best Magazines Indorse This Form of Investment

"Collier's Weekly," September 18, 1910

"A Tacoma society woman indulged herself in a 16-acre orchard. She soon found herself harvesting over 7,500 boxes of apples a year, which sell for about $17,000. There are many orchards that do even better than this, but the average will not run as high. If an orchard is intelligently and skillfully handled, it ought to yield from $700 to $900, and if the earning fall below an average of $400 to the acre, there is probably something serious the matter."

"Morrison's Chicago Weekly," March 9, 1911

It is frequently asked: Will not fruit growing be overdone in the Pacific northwest and cease to be profitable? This is answered by the fact, that owing to the dying out and destruction of orchards in the east, there are not more than half as many apples grown to-day as in 1895. Moreover, it would be impossible to glut the world's markets with such apples as are shipped from the northwest.

STEPHEN B. L. PENROSE, President of Whitman College, writing on the glories of the Northwest in the "Outlook" of July 24, 1910.

"It is difficult to talk about western productions to an eastern audience because they will not believe one-half of what is told, and will discredit the honesty of the teller through sheer incredulity. I think that a visit to the West will have a remarkable value in developing the imagination as well as the ability to believe what one is told. The richness of the northwestern soil needs no longer be taken upon faith, for its productions are here visible to the eye. Lands set out to apple trees sold as high as $2,000 per acre, and pay 40 per cent on that valuation."

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These figures are based upon the lowest actual returns experienced in the Bitter Root Valley, where good management prevails. The reader can easily reckon the minimum return upon an investment of any amount from $100 up, but for convenience we have taken an investment of $2,500, which would represent a 5-acre orchard, the ideal unit, and this should return annually after the fifth year from $1,500 to $3,000—frequently the profits are larger. In one instance, a cherry orchard has produced $3,200 per acre after paying all expenses.

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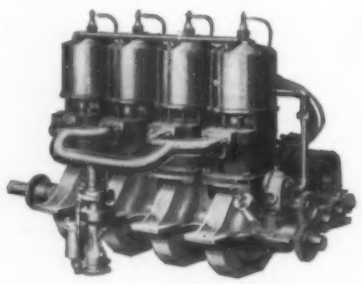

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—Extract from editorial in the first issue of THE NATIONAL POST

The NATIONAL POST

is a fortnightly magazine of character and purpose, which interprets the general news and the significant events of the world, and deals with the vital problems and the important persons of the nation. It has a strong, old-fashioned editorial page. It is a brisk and readable publication, with breezy fiction of a high quality, vigorous and authoritative articles, good illustrations and plenty of personalities and humorous touches.

THE NATIONAL POST is alive. It is a product of TO-day, alert, sober, progressive. It is owned by the people, and can not be bought off or diverted from the fight against incorporated wrong. Politically, it believes in the progressive Republicans and in the progressive Democrats. It has faith in the conservation of human life and happiness, and maintains this faith in the face of greed and exploitations. It stands for the concious employment of the force of organized government for the good of the whole people. In a word, it is an entity, it is a fortnightly magazine with a character.

Special Offer to Introduce The National Post

THE NATIONAL POST is published twenty-six times a year, and the cost is ten cents per copy on all newsstands, or $2.00 per year. To all those whose orders are received before June 15, 1911, THE NATIONAL POST will be sent for eight months—seventeen issues in all (retail value $1.70) for only $1.00.

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Notes and Queries.

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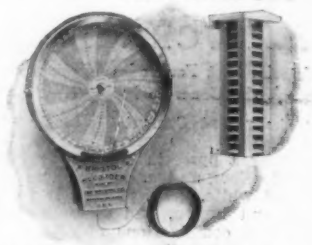
(12450) C. R. asks: Will you kindly explain the term "nominal horse-power" and the relation to actual horse-power? A. "Horse-power" and the calculation of the horse-power of steam engines is explained fully in SUPPLEMENTS 253 and 992; price ten cents each mailed. "Nominal horse-power" is an old term, now obsolete. It is the power of a steam engine calculated with seven pounds gage pressure of steam. As engines in these days rarely carry less than 60, and sometimes carry as much as 300, you can see how little the term means.

(12451) C. J. M. asks: Do any of your SUPPLEMENTS tell how to make a rheostat, and if so please give me the numbers, or send them and I will remit by return mail. Can they be made to regulate in 50 or 100 degrees? That is, if the first post was 800 deg., could the next one be so fixed that the heat would be only 50 or 100 deg. more, and so on for six or eight posts? A. You will find in SUPPLEMENT Nos. 865, 985, and 1594 the information you seek for making a rheostat. These papers are ten cents each. The grading of a rheostat to indicate degrees of temperature is not so easy. The temperature reached depends upon the time during which the current flows, the protection against radiation, the temperature of the surroundings, etc. If you can secure constant surroundings and take the reading after the current has flowed for the same number of minutes, you can make a rheostat into a rough or approximate indicator of temperature. If you only require the temperature within 50 deg., and allow for the change of resistance due to rise of temperature, you can grade the rheostat in degrees, although for the best results you should grade it by a thermometer. In any case the temperature will rise until the radiation losses equal the gain of heat. Then the temperature will become steady, and a reading may be made in temperature.

(12452) W. W. says: Will you kindly inform me, through your valuable information columns, concerning the arrangement of the wheels in the gyroscopic system used in the Brennan monorail installation? All descriptions which I have seem to speak of two wheels revolving in opposite directions. This, as it seems to me, must be an error, because such an arrangement suggests a constrained gyroscope in which, supposing them to be rigidly connected and of like mass and velocity of rotation, one wheel simply nullifies the so-called directive force of the other. If not rigidly connected, except as to the matter of mass, the use of more than one wheel would appear to lose all significance. A. The need for a double gyroscope with disks rotating in opposite directions on the Brennan monorail car arises from the action of a single disk in turning a curve. It is obvious that a single disk will oppose the turning of the curve, and that the car will force the disk out of its middle position in turning the curve. The mode in which the second disk remedies this difficulty is fully explained in the recent work by Crabtree, entitled "Spinning Tops and Gyroscopic Action," which we send for $1.50 postpaid. The two disks are not on one axis, but are so linked together that any lateral tilt of one is communicated to the other, but at the same time each is free to have a movement of precession. The result is that the car rounds a curve freely, while the gyroscope resists an upsetting force just as a single gyroscope would do. We cannot quote the explanation in full, but would refer you to the book named for further information.

(12453) F. D. S. says: In a recent conversation with a gentleman who is putting in a system of water works here, he made the statement that it would be impossible to force water through a 2-inch pipe if it were 10 miles long. I held that water would flow through such a pipe under proper conditions of incline without any force but its own head, but he stated positively that the friction would be so great that none would flow through so great a length of so small a pipe under any conditions. Will you kindly give me the facts in the matter? A. The gentleman must have been misunderstood. If water will flow through one foot of pipe under a given head, it will flow through another foot under the same head additional, and so on indefinitely. A 2-inch clean iron pipe, by D'Orcy's formula, would carry 0.03 cubic feet per second, if the slope is 1 for 200. Ten miles of 2-inch pipe (52,800 feet) under a head of 264 feet would discharge the same quantity, but this would be a serious loss of head for a pumping proposition; besides which, 10 miles of 2-inch iron pipe would



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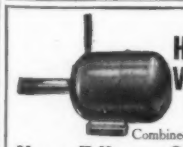

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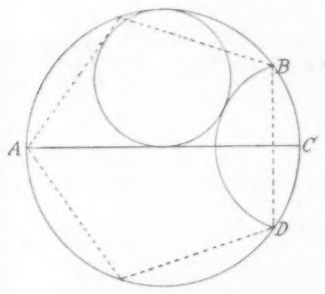
probably soon corrode and foul so as to reduce the flow to nearly or quite nothing, even under 264-foot head.

(12454) F. C. says: Kindly give me formulas for making dry battery, stating whether the old center carbon and zinc can be used, and a method for recuperating dry cells. A. Dry cells are made by using the zinc for the outer dish. It usually is worn out by the time the cell is exhausted. The carbon can be used over again. You will find full instructions for making a good form of dry cell in our SUPPLEMENT Nos. 1383, 1387, price ten cents each. Dry cells are not worth recharging. If opened and filled with a solution of sal ammoniac and water, they will give some more service, but will not be as strong as at first.

(12455) W. D. writes: A claims that the front wheels of an automobile revolve faster than the rear wheels when the automobile is running at high speed, by reason of the fact that the rear wheels are engaged by the chain drive and can revolve no faster than the sprocket itself, whereas the front wheels are uncontrolled, and the velocity of same is increased by reason of their own momentum. B claims to the contrary, for the reason that both wheels being exactly the same size in tire circumference, the rear wheels and the front wheels of an automobile will revolve exactly the same number of times regardless of the speed of the automobile. A. The rear or driving wheels of a car will turn more times in going a mile than the front wheels, but for a very different reason from that given by B. The reason is that the rear wheels have a certain amount of slip on the road, due to the pressure of the motor and the inertia of the car. The harder and smoother the surface of the road, the more is the slip or lost motion. On ice or in mud the rear wheels might turn swiftly and the car stand still, as an extreme case. The front wheels have no slip. They are not forcing the car forward, and simply turn as the car goes along. Every driving wheel has some slip. The drivers of a locomotive slip, the pulley slips under its belt.

(12456) H. H. R. asks: I was interested in the method you give in Notes and Queries No. 12396 for dividing a circle into five equal parts. Here is another even simpler, which I have devised. I wonder if it was invented also centuries before I was born! With a radius one-half of the given radius, draw a circle internally tangent to the given



circle. Draw a diameter of the given circle tangent to the smaller circle, as *AC*. From one end of this diameter as a center strike an arc tangent to the inner circle, and cutting the larger circle at *B* and *D*. The arc *BCD* is one-fifth of the circle. Both of these methods can be easily proved by trigonometry. Can anyone give a *simple* geometrical proof for each?

(12457) L. E. F. asks: 1. I wish to use 110-volt A. C. for my experiments, *reduced down to* 5 *or* 10 volts. Please tell me fully how to make two kinds of resistance, one of which is to be water. A. By far the best way to obtain a current with any desired number of volts from an alternating current is through a transformer. A resistance can be used if you desire. You will find a suitable transformer described in SUPPLEMENT 1572. This will give an alternating current of any desired volts by taking off taps in the proper places, as described in the article. Should you wish a direct current, you can use an electrolytic rectifier, such as you will find in SUPPLEMENTS 1644, 1679, and 1767. We will send these papers at ten cents each. 2. Does a resistance take away current to work it? I mean does it register any more on a meter to use 110-volt A. C. with a resistance in circuit, than if there was no resistance in circuit? A. Resistances hold back the current so that so much does not flow. 3. Are short contributions to the SCIENTIFIC AMERICAN, such as experiments, little kinks and helps in mechanics and electricity, etc. paid for if accepted? If so, what are the rates? A. Suggestions for the Handy's Man's Workshop Department of the SCIENTIFIC AMERICAN are paid for at the rate of $7 per column. Drawings and photographs are paid for separately according to their character. 4. Are the vibrations of 110-volt A. C. fast enough to run a 1-inch spark coil? A. A 1-inch spark coil may be run with four to six cells of battery indicating 6 to 10 volts as required. A 110-volt current would burn out the primary coil in a very few seconds.

Electricity

Kamchatka Wireless Service.—The Russian Government recently erected wireless posts so as to make connection between Nikolaivsk on the Amur River and the Kamchatka region. The distance between the two stations is about 800 miles, one being placed at the former locality and the second at Petropavlovsk. The metallic masts for the aerial are 240 feet high. Gasoline engines of 15 horsepower are used to operate the dynamos which supply the current. Signals are now sent very well between the two posts, and the public can make use of them. As there is no postal service in the Kamchatka region during the winter, this will be a good feature.

Ten-thousand-volt Storage Battery.—A paper was recently read by Mr. Swinton before the Roentgen Society of England, describing a storage battery with an electro-motive force of 10,400 volts. The battery consisted of 4,800 cells. Each cell was made of a glass test tube of quarter-inch bore, containing corrugated lead sheets separated by celluloid strips. Dilute sulphuric acid was used for the electrolyte. The battery could not be safely charged at a rate of more than 10 milliamperes, while the discharging rate was under 150 milliamperes. The internal resistance of the battery was between 3,000 and 4,000 ohms. Under full pressure the current would jump a gap of 2.5 millimeters. This, however, was not absolutely steady, for the arc produced a high musical tone, and if a Leyden jar were used, the arc would break up into a series of sparks of high frequency.

Preparing to Enforce the Wireless Ship Act.—To facilitate the enforcement of the Wireless Ship Act, naval wireless shore stations of the United States will receive during the months of May and June between the hours of 8 A. M. and 6 P. M. (time of shore station) wireless messages from merchant vessels subject to the act, to show that such vessels are "equipped with an efficient apparatus for radio-communication in good working order in charge of a person skilled in the use of such apparatus." The Department of Commerce and Labor and the proper collectors of customs will then be advised. Such messages must, of course, be sent by a vessel at least 100 miles distant from the naval shore station, and preferably from a point which will show the average maximum radius of the ship's apparatus. The message should be prefaced by the words, "For Commerce Labor, Washington," and should give the name and the nationality of the vessel; the latitude and longitude at the time of sending message; the full name of operator sending message; and the master's signature.

Dispatcher's Control for Electric Lines.—A novel device was recently installed by the Indianapolis & Louisville Traction Company in its power plant, whereby the train dispatcher is given absolute control of all cars on the road at all times. The circuit breakers on the switch panels may be tripped by a weighted lever controlled by a small double throw switch on the dispatcher's desk. The device is arranged so that the engineer cannot replace the circuit-breakers until the dispatcher has thrown his switch back to its normal position. The apparatus overcomes the objection of having a direct switch connected with the feeder system in the office of the train dispatcher. The use of the device is for protection of the road and prevention of accidents. If the dispatcher should make a mistake, or if a crew should overrun an order, or an extra or a regular train fail to report at a specified time, the dispatcher can instantaneously assume positive control of the situation by a mere movement of his hand. Of course the rules of the road are that when the power leaves the line, every car shall at once come to a standstill, regardless of its location on the system, and report to the dispatcher. It is said that several fatal interurban accidents of the past few years have occurred under conditions when it would have been possible for the dispatcher to have prevented the wreck had he had any quick and positive way of bringing traffic to a standstill after he knew that an accident was imminent.

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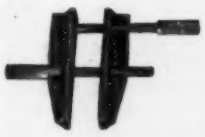

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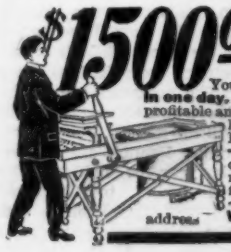

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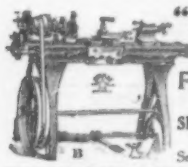

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Aeronautics

Willard in Idaho.—Mr. C. F. Willard, in his Gnome engined Curtiss biplane at Idaho Falls, Idaho, on April 25th, experienced difficulty in flying on account of the very light air that day and the altitude of 4,700 feet. At no time could he get over 100 feet high. The grounds were surrounded by trees, and Willard found he could fly best over the plowed fields outside. The meet was well attended, there being over 5,000 people, coming from all towns within a radius of 100 miles. This was the second flight in Idaho, the first having been made at Boise City the week before.

Two Brothers Killed by a Fall in Russia.—Within the past month no less than four men have fallen to their death when flying in aeroplanes. On May 1st, while flying together in a biplane at Sebastopol, two Russian officers, named Mattievich, were dashed to the ground and killed. The same day, Wynmalen experienced a bad fall at Paris. He dropped 300 feet, but happened to strike in a pool of water that was sufficiently deep to save him from serious injury. The following day Lieut. Roser, of the German army, while flying above the station at Havsheim (near Mulhausen) had a bad fall of between 100 to 200 feet. He is reported to have been fatally injured.

The New Krupp Aerial Torpedo.—The Krupp firm in Germany has just brought out a new aerial torpedo, which is said to be far in advance of anything in this line heretofore produced. This torpedo, which has been developed from a Swedish invention, is self-propelling and without reaction upon the airship or aeroplane from which it is discharged. It operates somewhat on the principle of a sky-rocket, being composed of two parts, viz., an explosive head and a tail chamber containing a slow-burning powder charge, the gases from which are discharged through tubes at the rear and drive the torpedo forward. The initial start is given the projectile by means of a launching device operated by a light powder or by electricity. The gas discharge tubes are set at an angle, so that the projectile rotates on its axis as it moves forward. A very sensitive percussion device is used, and is provided with a safety lock, which is only released when the projectile has attained a certain speed of rotation. This percussion device is so sensitive that it will explode the torpedo the instant it strikes an inflated gas bag. Patents for the torpedo have been taken out recently in America.

Number of Certified Pilots.—According to official figures obtained by *The Aero* from affiliated clubs of the International Aeronautical Federation there were at the end of the year 1910 no less than 516 certified pilots. The actual number of licenses issued by all the clubs amount to 578, but this is subject to a deduction of 26 names of aviators now dead and of 36 names of pilots who have taken out licenses in more than one country. When the figures have been corrected in this way, the number of aviators credited to each country is as follows: France, 339; Germany, 43; England 39; Italy, 27; Belgium, 24; United States, 18; Austria, 18; Switzerland, 3; Denmark, 3; Spain, 2. Day by day the English list is growing, and aviation is being so seriously studied in the United Kingdom now that of a certainty the above figures will be strikingly more to the credit of that country by the month of June even. At the Brooklands flying ground there are now about 40 sheds occupied, and only on days when a gale is blowing are no flights made there. On most days three, four, and five machines may be seen aloft at one time. At Hendon there are two schools where pupils are trained daily, and the sight is as interesting as at Brooklands. On Salisbury Plain and at Eastchurch and in the New Forest numerous sheds are occupied, while in many parts of the country individual aviators may be found. The prospects are of the rosiest in England, and there is sure to be an immense fillip given to the movement by the Gordon Bennett aerial race, which will this year be held in the United Kingdom owing to Grahame-White's victory over the French and Americans in the 1910 race.

Engineering

Panama Needs Five Thousand Tons of Dynamite.—It is estimated that 5,000 tons of dynamite will be required to carry on the work of construction on the canal and the Panama railroad during the fiscal year ending June 30th, 1912. Of this amount, 3,250 tons must be 45 per cent nitro-glycerine, and 1,750 tons must be 60 per cent nitro-glycerine. For the present year, the estimate was 6,864 tons.

London Passenger Traffic Grows Apace.—The estimated population of Greater London in 1903 was 6,806,000, and in 1909 7,430,000. In the interim, the traffic had grown as follows: Local railway companies from 291 millions to 441 millions; street cars from 394 millions to 687 millions; omnibuses, from 287 millions to 311 millions, the total traffic per year having thus increased from a total of 972 millions in 1903 to 1408 millions in 1909.

Damming the Mississippi.—Work is being prosecuted on the great dam, seven-eighths of a mile long, across the Mississippi at Keokuk, Iowa. The structure will rise 32 feet above the river bed, and along its length will be 119 flood gates 30 feet wide and 11 feet high. At the end of the dam will be the lock gates and a huge power house 1,400 feet long and 123 feet wide, in which will be mounted 30 hydraulic electric power generating units. The initial installation of 120,000 horse-power is to be completed July 1st, 1913.

Cofferdam Around "Maine" Completed.—Now that the cofferdam around the wreck of the "Maine" is about completed, it should not take long to pump out the elliptical basin which has been formed, and expose the wreck of the ship. The first care will be to make a thorough search for bodies. After that will come the investigation of the hull to determine the real character of the explosion which sent the ship to the bottom. Fears have been expressed as to the stability of the caissons, but there is no doubt that army engineers have given this matter most careful consideration.

Oregon Agricultural College.—An engineering show, patterned after the electrical shows which have been given in the large cities of the country, was recently opened by the faculty and students at the State Agricultural College at Corvallis, Oregon. The apparatus and work of civil, mechanical and mining engineers, and that relating to forestry, was exhibited, the civil engineering section being devoted to good roads, the mining to ores and processes, the mechanical engineering to shop work products and machine operation, and the electrical to exhibitions of high tension current, welding processes, wireless telegraphy, etc.

First Auxiliary Sailing Ship.—It is not true that the auxiliary bark "Quevelly" was the first auxiliary sailing vessel to leave the port of New York under her own steam; for several years ago the big five-masted German auxiliary ship "Rickmers" sailed from New York under her auxiliary power. Over half a century ago, moreover, two American auxiliary sailing ships, "Edith," 1842, and the "Massachusetts," 1846, were built in this country, each being equipped with both sail and steam power. They were full rigged, and their propellers were so adjusted that they could be turned up out of the water. Nor should we forget the old "Savannah," 1819, which was, strictly speaking, a steam auxiliary.

Riveted-plate Cable Suspension Bridge.—A suspension bridge of curious novelty has lately been built over the Oder River, Breslau, Germany. It is a highway suspension bridge of 415 feet span. The supporting chains consist of four flat bands, each made up of 12 thicknesses of plate riveted together. The floor load, taken up by the suspenders, is distributed between the four bands of each cable by a complicated system of equalizer bars and links. The Germans are nothing if they are not theoretical, and so we learn from *Engineering News* that "the adoption of bands for the suspension cables was due to the desire to secure maximum flexibility in a vertical direction in order to minimize the secondary stresses near the towers arising from temperature changes."

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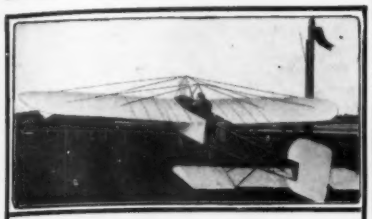

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Science

The Temperature of Italy.—Dr. Filippo Eredia has just published an exhaustive work on this subject, comprising tabulated records of the temperature, by ten-day periods, from 1866 to 1906, for the meteorological stations of Italy; also statistics of the variability and the range of temperature, and a large number of charts. This bulky folio volume, which is issued by the Ufficio Centrale di Meteorologia at Rome, forms a fitting companion piece to the same writer's work on the rainfall of Italy, published in 1908.

Reflection of Ultra-violet Light by Snow.—Prof. J. von Kowalski, in a letter to *Nature* (London), describes his observations of the spectra of sunlight reflected by snowfields in Switzerland. He finds that the ultra-violet rays are reflected by snow almost in their entirety. This fact helps to explain the trying effects of such light upon the eyes, and suggests the advisability of wearing, during a period of snow and sunshine, glasses that are opaque to the ultra-violet rays.

New Physical and Chemical Tables.—The preparation of a new edition of the standard work now known as Landolt & Börnstein's "Physikalisch-chemische Tabellen" has been undertaken by Dr. Börnstein, of Berlin, and Dr. Roth, of Greifswald. These two writers have set an admirable example in addressing a circular to men of science and scientific institutions throughout the world inviting suggestions as to additions, omissions or other changes likely to increase the value of the work. Such suggestions should be sent either to Geh. Reg.-Rat Prof. Dr. R. Börnstein, Landhausstrasse 10, Wilmersdorf bei Berlin, or to Prof. Dr. W. A. Roth, Karlstrasse 8, Greifswald.

An Arctic Coal Mine.—According to *La Nature*, the most northerly coal mine in the world is that of the Arctic Coal Company (an American concern) at Advent Bay, on the east coast of Spitzbergen. The coal crops out at the surface of the ground several hundred feet above sea level, and is brought down to the harbor by a funicular railway. The company has about 150 men at work, chiefly Norwegians, who remain on the spot all the year, although Advent Bay is blocked by ice and inaccessible to vessels for eight months; viz., from November to June. About 6,000 tons were taken out last year, but the maximum output has not yet been reached. The chief market for this coal is Norway, which has no coal mines of its own.

The Antarctic Expeditions.—The whole scientific world is watching with interest the progress of the numerous expeditions that are now laying siege to the South Pole, or are preparing to do so. There is, of course, much international rivalry, and apparently each party is disposed to regard as inviolable by the others the field of operation that it has chosen. The most surprising piece of news that has come from the scene of action up to date is that Amundsen, who sailed in the "Fram," ostensibly for the Arctic, has turned up in the Antarctic; viz., at the Bay of Whales, an inlet in the ice-barrier at 165 deg. W. longitude. Here he was found by the "Terra Nova," on the return voyage of the latter after disembarking Scott at McMurdo Sound.

Halley's Comet.—Prof. E. E. Barnard informs us that he is still observing Halley's comet with the 40-inch Yerkes telescope. It is now growing rapidly fainter. His last observation was made on April 25th, when the comet was estimated to be of the sixteenth magnitude in a poor sky. On April 23rd, in a good sky, it was estimated 14½ or 15 magnitude. At the observation of April 25th, the comet was 463 million miles from the sun, and 414 million miles from the earth. It is now very small to the eye, and feeble in its light. After its reappearance next autumn or winter from behind the sun in the morning skies, it will perhaps be out of reach of any visual telescope, but Prof. Barnard believes that it may possibly be followed longer with the great photographic reflectors. The comet cannot be followed now very much longer in the evening skies, because of the lengthening of twilight, and its approach to the direction of the sun.

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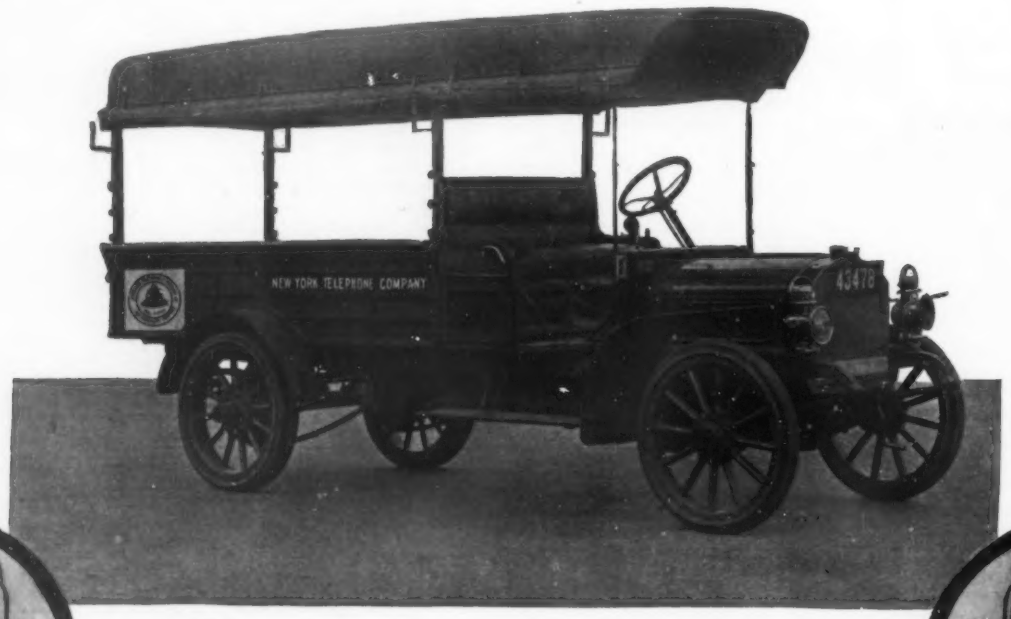

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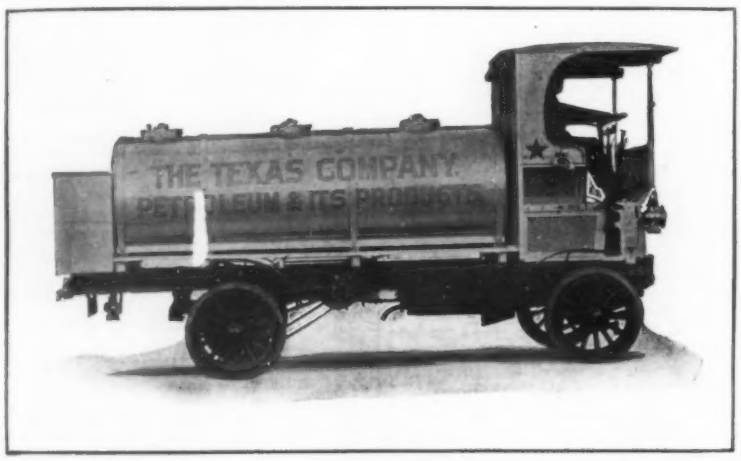

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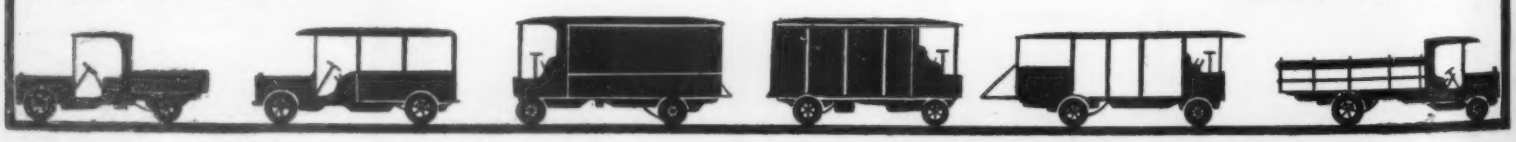

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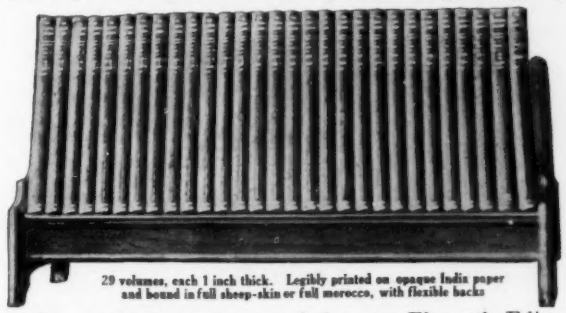

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